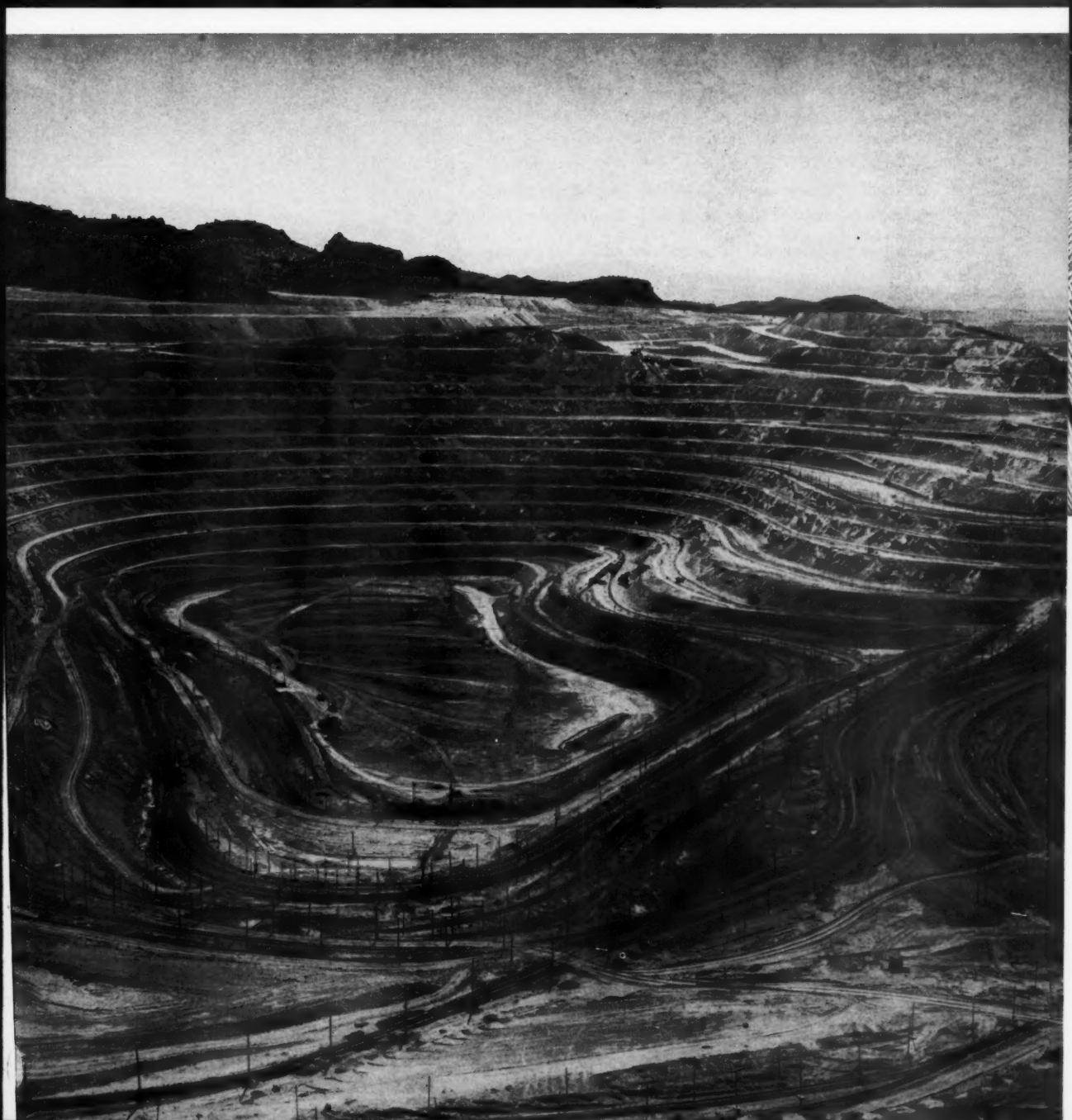
MINING CONGRESS JOURNAL

JANUARY 1960



DENVER Engineered AGITATION

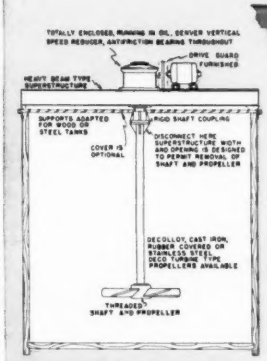
We have the tools to help you solve your TOUGHEST Agitation Problems... *Profitably!*

✻ DENVER Agitators for Mixing and Leaching

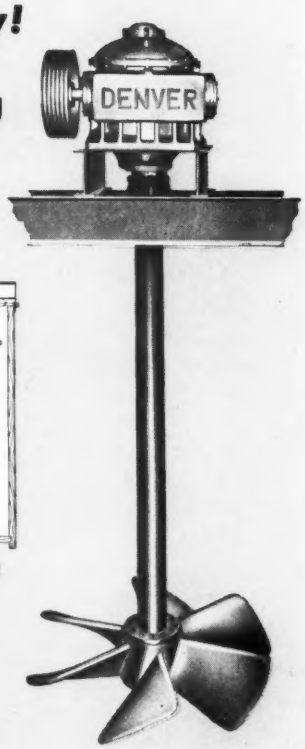
New Turbine Type Propeller Agitators have been developed up to 120" in diameter propeller size for use in large diameter tanks. This permits operation at slower speeds and at lower horsepower, yet effective agitation is obtained with pulps and slurries as coarse as 8 mesh. Special propeller blade design features eliminate cavitation, minimize wear, assure long life.

Equipped with DENVER Reducer Drive, a compact, totally-enclosed, self-lubricated speed reduction drive. Many speed selections, simple construction, easy, trouble-free maintenance.

Extensively proved in uranium mills—and for pulp suspension applications in leaching, mine back-fill holding tanks and chemical processing.

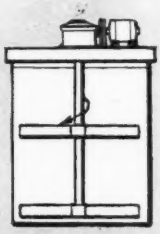

DRIVE GUARD FURNISHED
RIGID SHAFT COUPLING
SUPPORTS ADAPTED FOR WOOD OR STEEL TANKS
COVER IS OPTIONAL
DISCONNECT HERE SUPERSTRUCTURE WIDTH AND OPENING IS DESIGNED TO PERMIT REMOVAL OF SHAFT AND PROPELLER
DECOLLOY, CAST IRON, RUBBER COVERED OR STAINLESS STEEL PROPELLERS AVAILABLE
THREADED SHAFT AND PROPELLER

TURBINE TYPE AGITATOR



SIZES TO 120" AND LARGER DIAMETER

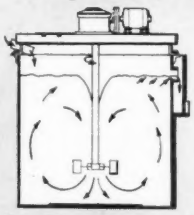
✻ DENVER Agitators for Suspension



PADDLE AGITATOR

DENVER Paddle Agitators are designed for applications involving the gentle mixing of solutions or slurries containing solids of fine particle size. Equipped with DENVER vertical shaft speed reducer.

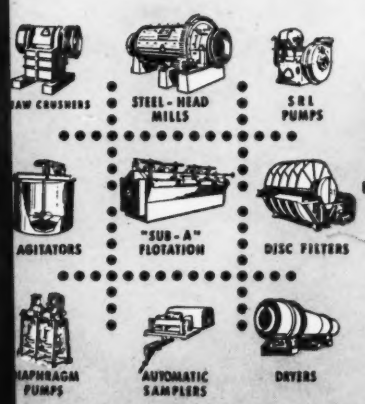
✻ DENVER Agitators for Mixing, Precipitation, Stripping



VERTICAL TURBINE AGITATOR

DENVER supplies agitators of the vertical turbine type for intimate mixing, precipitation and stripping. A complete line of worm gear drive units are available to power these impellers at correct horsepower and speed for your applications. Mixing propellers available in full range of sizes to provide desired mixing intensity.

✻ **DENVER can supply Agitators and Mixers in a full range of types and sizes . . . for conditioning, mixing, scrubbing, leaching, precipitation, aeration, etc., for either batch or continuous operation. Write for Bulletin No. A2-B4.**



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Opinions expressed by the authors within these pages are their own and do not necessarily represent those of the American Mining Congress.

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ON OUR COVER

Kennecott Copper Corporation's open pit copper mine at Santa Rita, N. M. — one of the largest of its kind in the world — is nearly a mile across and 800 ft deep. Copper has been mined from this location since the early 1800's and production is currently about 22,500 tpd.

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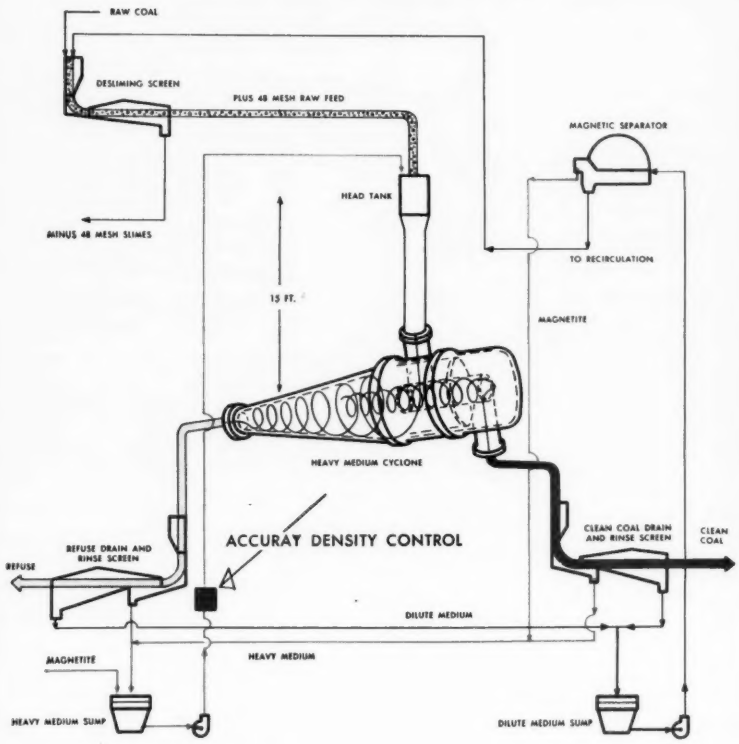
FLOW DIAGRAM OF HEAVY MEDIUM CYCLONE WASHING SYSTEM



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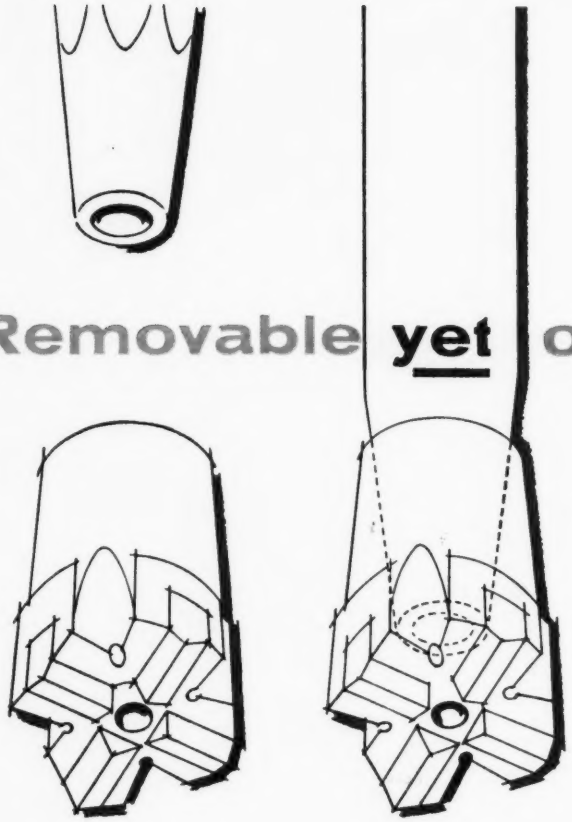

Removable **yet** one-piece strong

That's why Timken® air-leg bits save you time and money

YOU can keep right on using your good drill steels after the carbides wear out—if you're using Timken® bits. They're removable. Not so with intrasets; you have to throw away good drill steels after the carbides wear out.

You need only a pocketful of Timken removable bits for a whole day's work. You have to lug at least an armful of intrasets to the face.

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CHIPS CLEAR FASTER because 1) Five front holes shoot water or air directly against the rock face and 2) Deeper, wider wing clearance lets chips wash back faster.

TIMKEN®

removable rock bits

At Keystone Portland Cement Company's Bath, Pa., quarry, this Mack LVX takes on one of the fifty 22-ton loads it must haul each day to keep on schedule.

A 15% grade has to be tackled on the mile-long round trip from shovel to crusher. This Mack hustles up-grade with a full payload while its empty companion barrels back down to the shovel.

Our MACKS stay on the job

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Keystone Portland Cement Co., Bath, Pa., expect each of their trucks to deliver 800 tons of rock per 7-hour shift . . . and do it at lowest cost. They get the job done with Mack 22½-ton LVX dumpers—fast, reliably and with surprising fuel economy.

Quarry Superintendent Harry Michaels says, "Our Macks give us top on-the-job performance, taking time off only for routine maintenance. They keep working day after day, month in, month out."

Why not team up *your* big shovels with Mack trucks? They'll make fast hauls between quarry and crusher. They can be depended upon to meet scheduled tonnage requirements because Macks don't bog down or break down when the going gets rough . . . handle easily the heaviest loads under the most demanding conditions.

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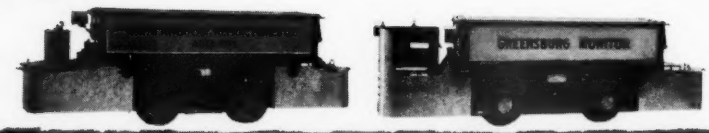
National Mine Service Company

GREENSBURG MINE LOCOMOTIVES



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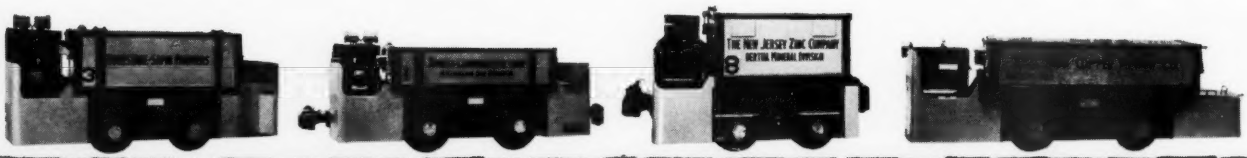

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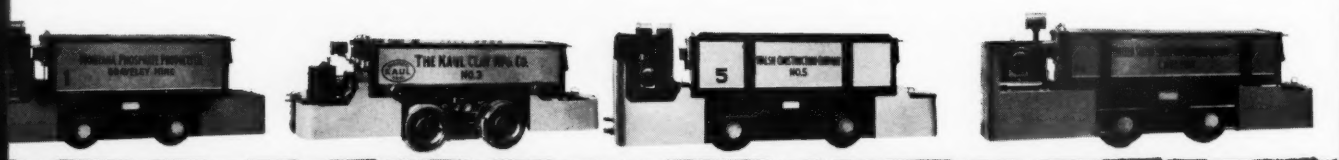
THE FAMOUS GREENSBURG LOCOMOTIVES



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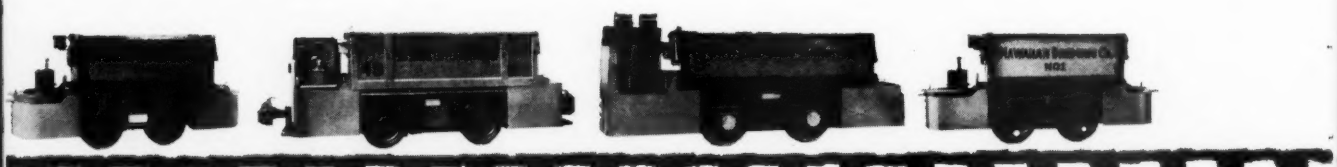

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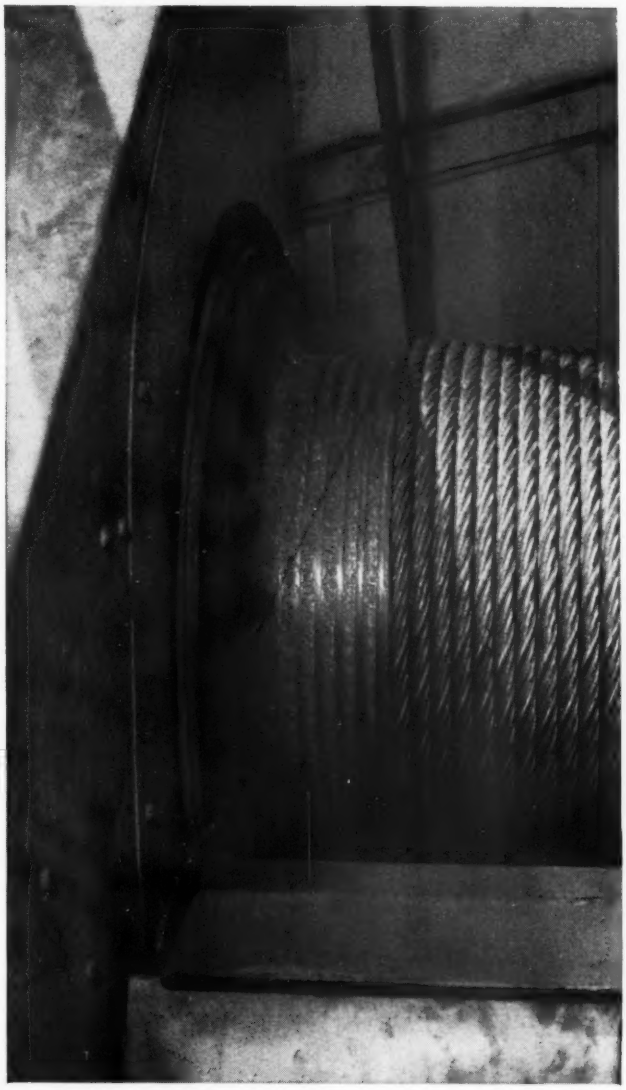

"...we would never hesitate to recommend it"

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This company continues: **"We have been using your Roebling Herringbone* for about one year. We find it is one of the best ropes we have ever used, outlasting previous ropes three to one. It is good that such a reliable rope is available."**

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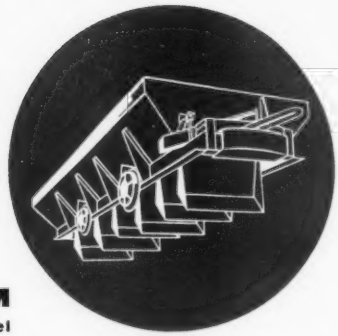
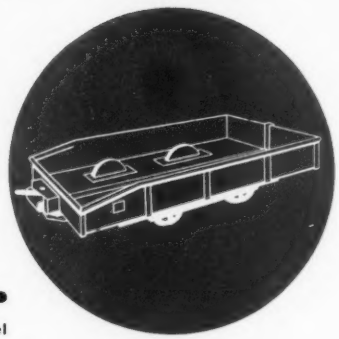
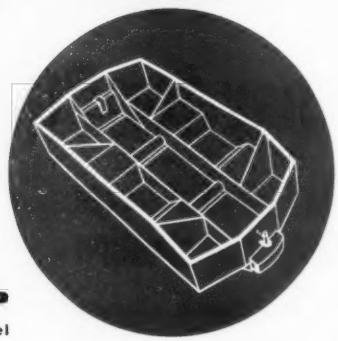


DROP BOTTOM
4 wheel or 8 wheel



END DUMP
4 wheel



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4 wheel or 8 wheel

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- simply by tightening two cap screws!

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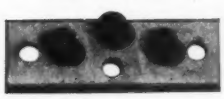
Straight-Thru Connector



Three-Way Plate

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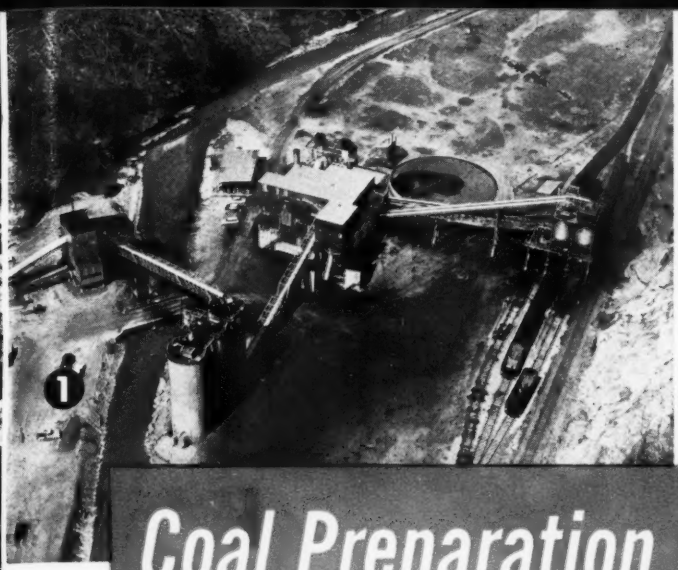

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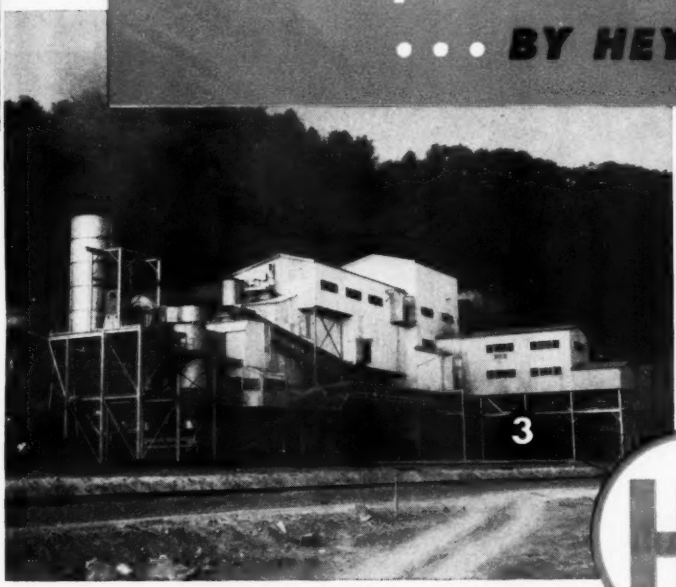

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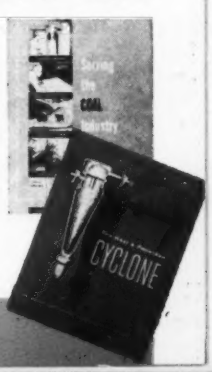

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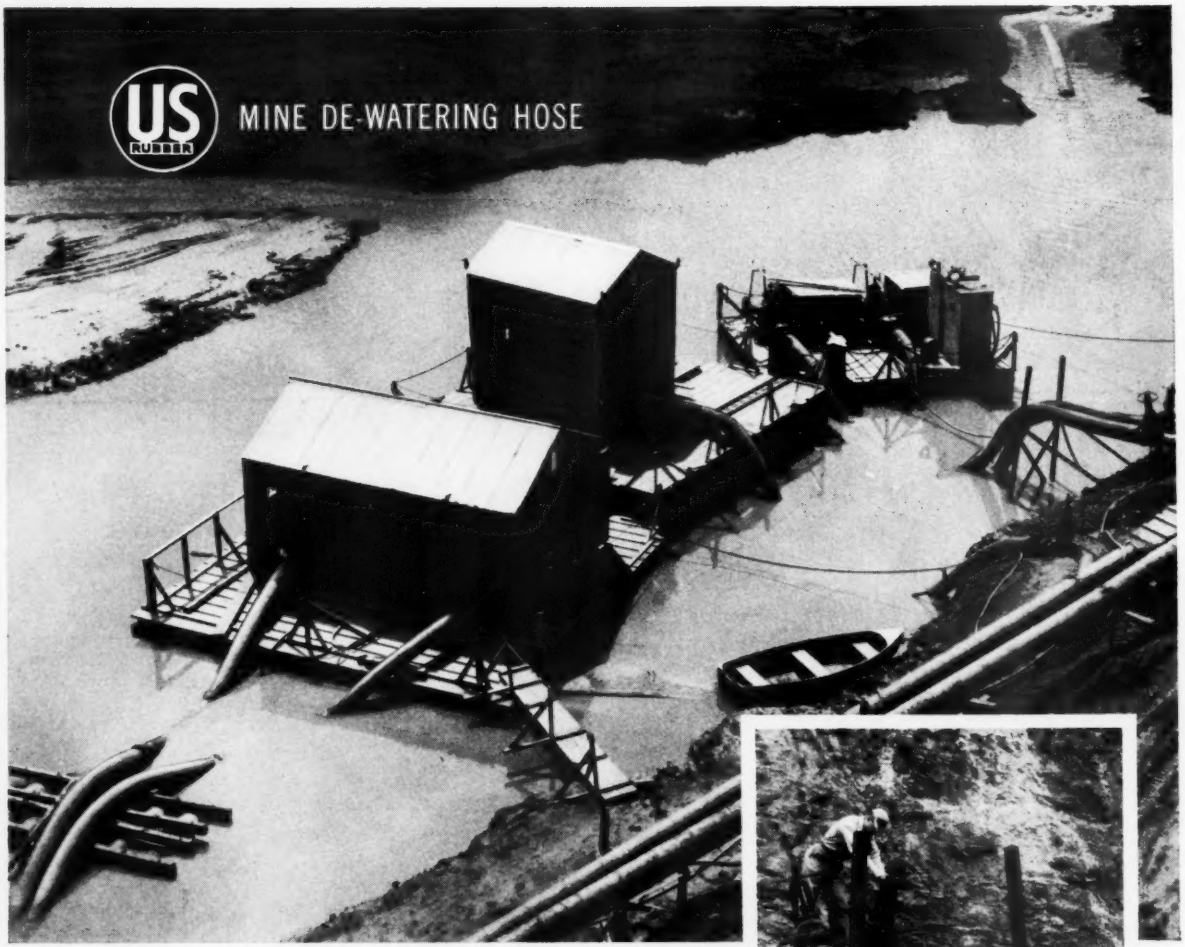

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What you can do: Let a Standard Oil lubrication specialist help you find ways to eliminate your lubrication problems. One of these men is on the staff of each of the 48 district offices in any of the 15 Midwest and Rocky Mountain states. Or write **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**

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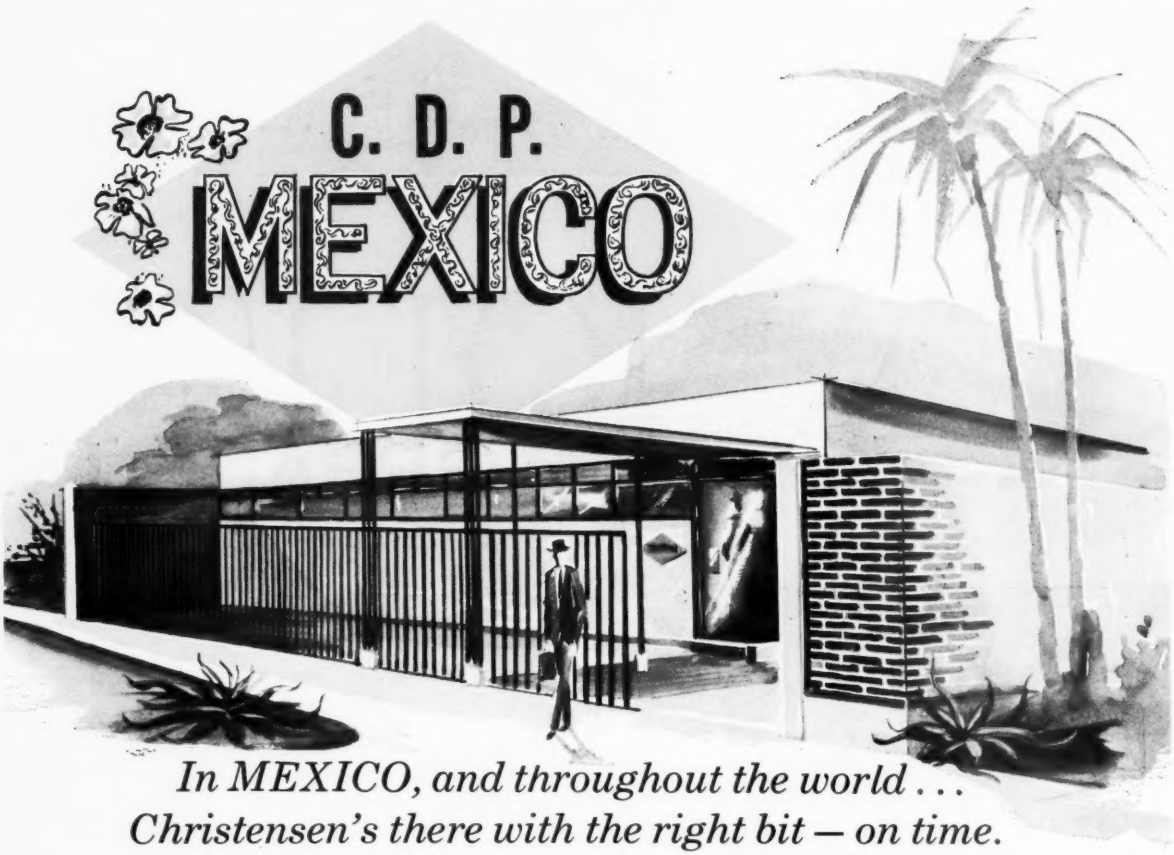

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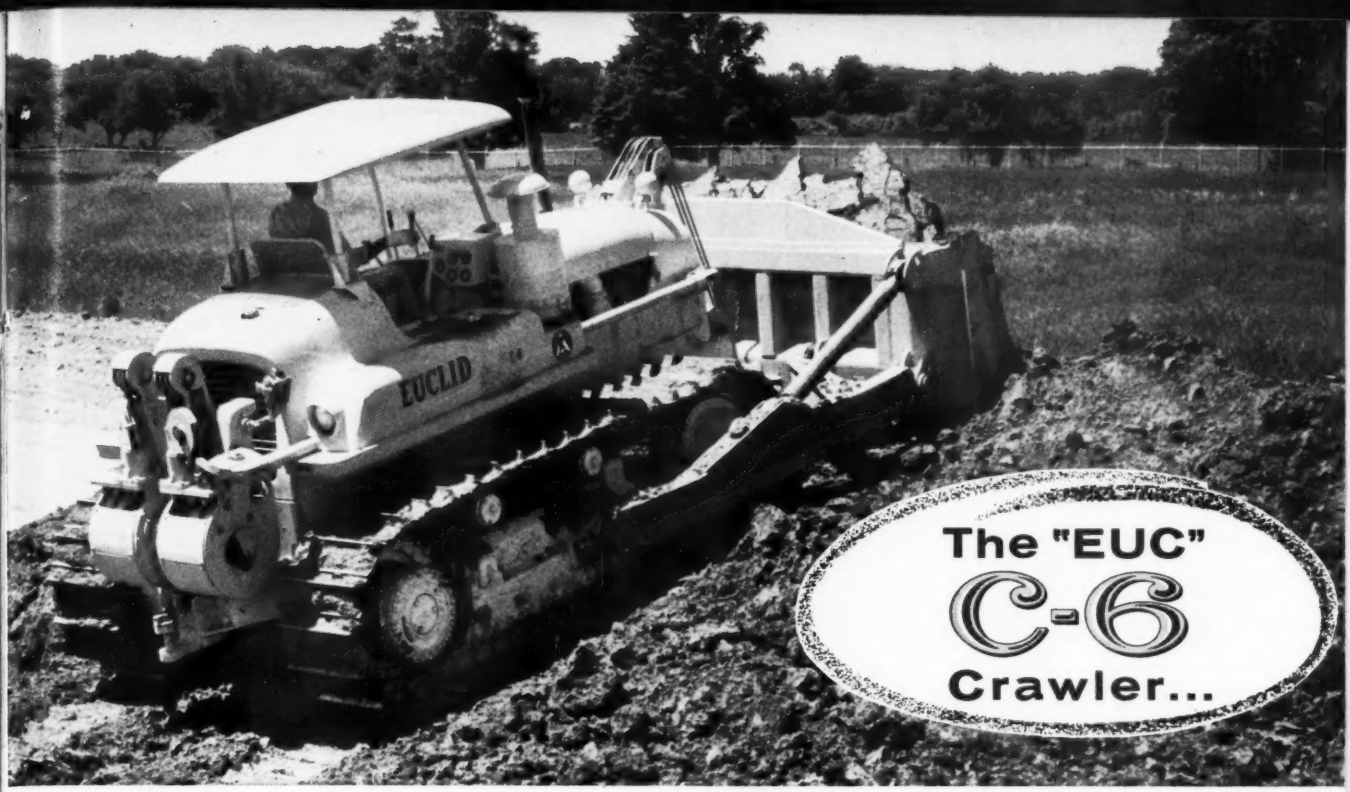

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Proven Torqmatic Drive . . . performance tested and proved in thousands of Euclid earth-movers on the toughest jobs.

Full Power Shift . . . no master clutch . . . easy operation and "fast as a fox" maneuverability that cuts work cycle time.

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No other Euclid product has ever had the thorough testing —both on proving grounds and on actual jobs—that the C-6 tractor has undergone during the last 5 years. All of the product refinements and improvements resulting from this exhaustive test program, plus Euclid's really new concept of crawler design, make C-6 performance a new standard for comparison in the 200 h.p. tractor class.

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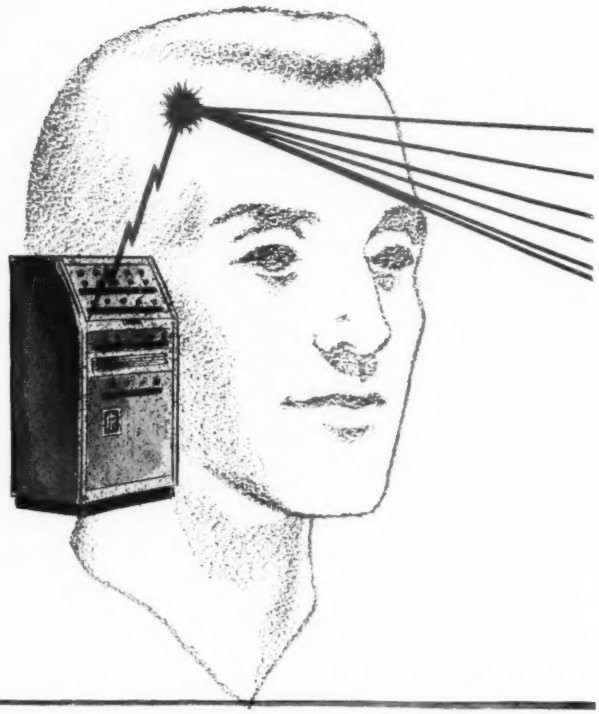

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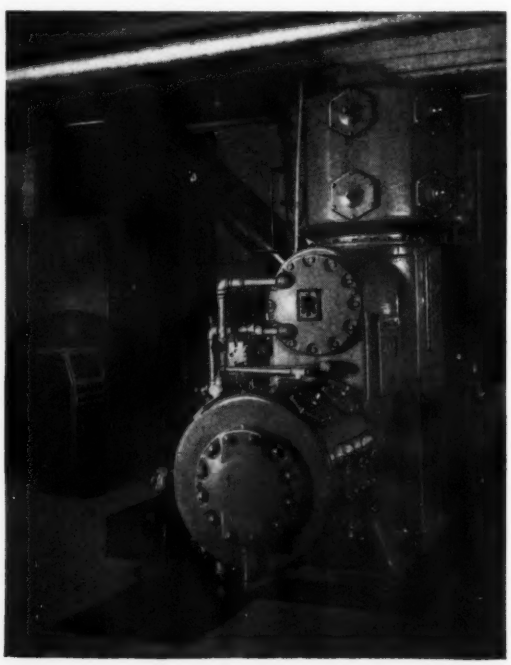
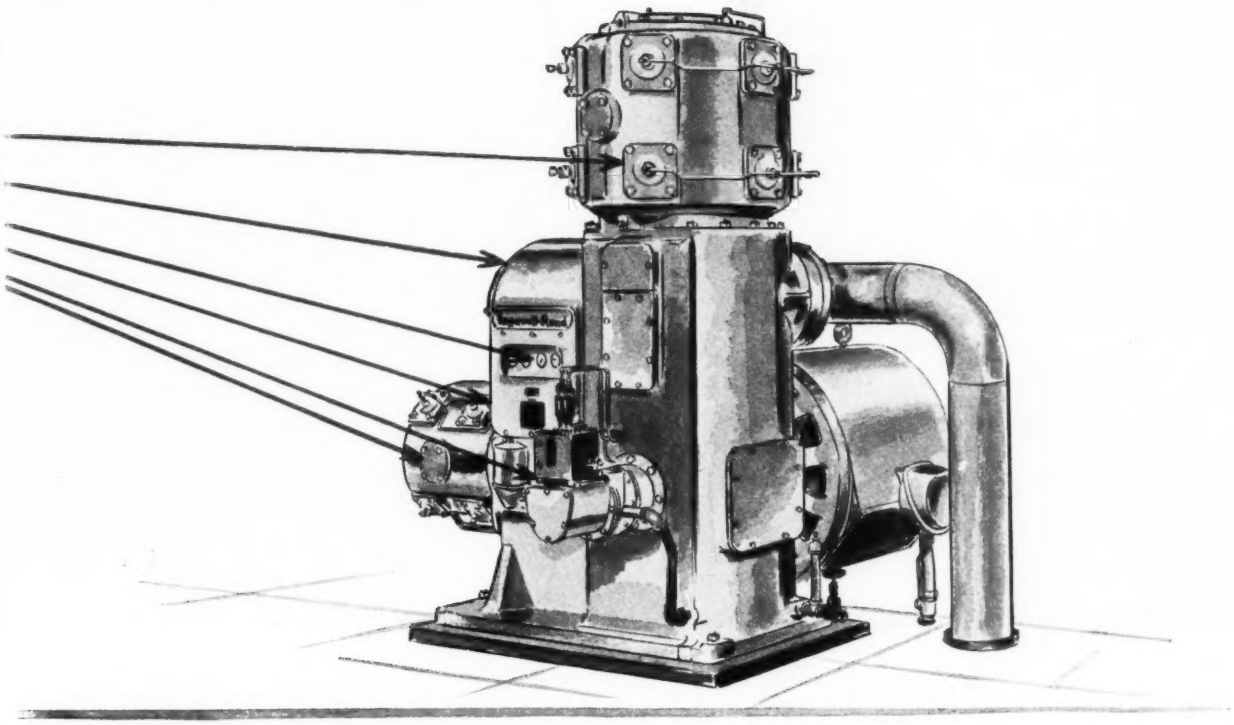


New 'Tendamatic control brings automatic supervision to the COMPRESSOR PLANT

(left) 'Tendamatic control of this two-stage heavy-duty air compressor, an Ingersoll-Rand type XLE packaged unit with built-in motor, assures maximum protection of capital investment, maximum manpower utilization, continuity of production and lower maintenance expense.



Compressor "Think for Itself"

Ingersoll-Rand's new *'Tendamatic* control is like a tireless attendant who keeps inspecting and checking the operation of the compressor every second.

All you need to do is push the "start" button on the control console. The *'Tendamatic* does everything from then on. You walk away knowing that the compressor is in good "hands". And here's why:

This completely automatic control system anticipates operating difficulties before they develop. It keeps an eye on air pressure and temperatures... lubricating-oil pressure and temperature... the cylinder lubricator... checks the float level in the condensate trap. It checks for leaking valves and mechanical failure of running parts.

Anytime there is a variation from normal compressor operation, the *'Tendamatic* identifies the nature of the malfunction and gives you audible and visible warnings in time to take corrective measures. If the warning is ignored or forgotten, *'Tendamatic* shuts down the compressor before any damage results. If oil pressure fails or if any vibration occurs, it stops the machine *at once* without advance warning.

These built-in safeguards entirely eliminate routine inspection and supervision... detect trouble before it can do any harm to the compressor... put all maintenance on a low-cost *preventive* basis.

For almost 90 years, Ingersoll-Rand has been making engineering dreams come true—with the constant improvement of I-R equipment to meet or anticipate the changing needs of America's growing industries. When you need equipment for compressing air or other gases, moving liquids, condensing steam, drilling rock, creating vacuums, or for industrial cooling, *think first of Ingersoll-Rand.*

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Bumps and dips are taken in stride by the Joy 18 SC. Car bends with the floor to maintain traction and avoid "roofing." Hydraulic "traction boosters" can be engaged when extra effort is needed on bad bottom or steep grades.

SIX-WHEELED DESIGN SELECTED AT BARNES AND TUCKER MINE NO. 15

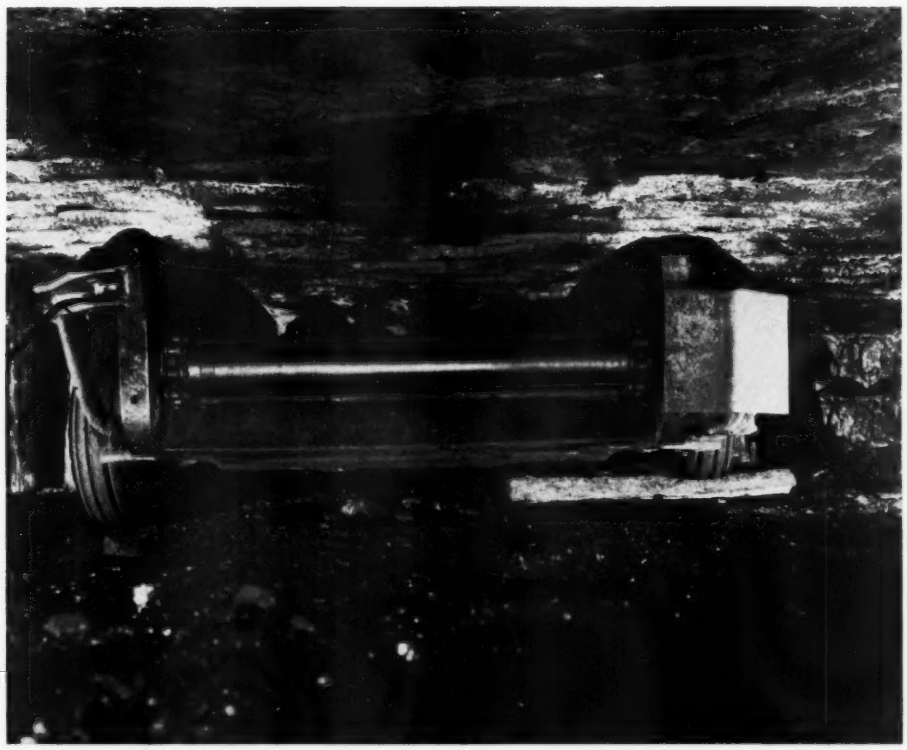
Revolutionary Joy 18SC Shuttle Car Sets Haulage Records

The value of the hinged-center design in shuttle cars has been thoroughly proven at the No. 15 Mine of Barnes & Tucker Coal Co. Improved trip time and increased capacity enabled Joy 18 SC Shuttle cars to establish haulage records in the mine.

Mine management attributes the outstanding performance to the ease with which the cars can be operated. The 18 SC cars are averaging more trips per shift, because the operators find they can tram at top speed in comfort and safety. Sitting between the wheels, they get a smoother ride, and needn't worry about "roofing." Since the car bends in the middle, it hugs the floor on bumps and dips. This not only prevents damage from striking the roof, but also gives extremely good traction.

Based upon the excellent results at Barnes & Tucker, and other mines, Joy is certain that another pioneering effort has paid off underground. The hinged design has proven that it can increase haulage efficiency in low and medium seams, and is the car of the future in this type of operation. Let your Joy representative give you complete details.

Operator gets better protection riding between wheels on the 18 SC. This, plus easy steering, enables him to tram at top speed all the way.



Straight-through conveyor gives 30-second unloading time for 4 ton loads at Barnes & Tucker No. 15.

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Anaconda's SH-D Cable gives many years of dependable service in spite of heat, moisture, kinks, rocks and runovers!

How many shovel cable hazards can you count in this picture from the Maumee Collieries? Rocks . . . moisture . . . kinks . . . danger of runovers—they're all there. Yet the first installation of Anaconda's rugged SH-D Shovel Cable has resisted them all—*for 10 long years!*

It's proof again of the way Anaconda's in-the-field experience with Shovel Cable pays off in a superior cable for you. The important knowledge gained from use and testing of SH-D Cable *on the job* in our own mines goes into the design and manufacture of Anaconda Shovel Cable.

For example, the insulation is Anaconda Butyl (AB). Nothing can beat it for withstanding ozone, heat and moisture. Patented rubber cores cushion the ground wires and help prevent breaks from kinks and runovers. SH-D has a neoprene jacket that is exceptionally tough and abrasion-resistant. And every design, every component has been job-tested—your assurance of superior quality and performance.

Call on the Man from Anaconda with your cable problems. Or see your local Anaconda distributor. For new descriptive Bulletin DM-5818, "Anaconda Securityflex Portable Cables for the Mining Industry," write: Anaconda Wire & Cable Co., 25 Broadway, New York 4, New York.

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◀ For a decade, the Anaconda SH-D Shovel Cable you see here has been giving dependable service for the Maumee Collieries, Jasonville, Indiana. Its many superior design features enable it to resist on-the-job hazards that would knock out ordinary shovel cables.

ASK THE MAN FROM

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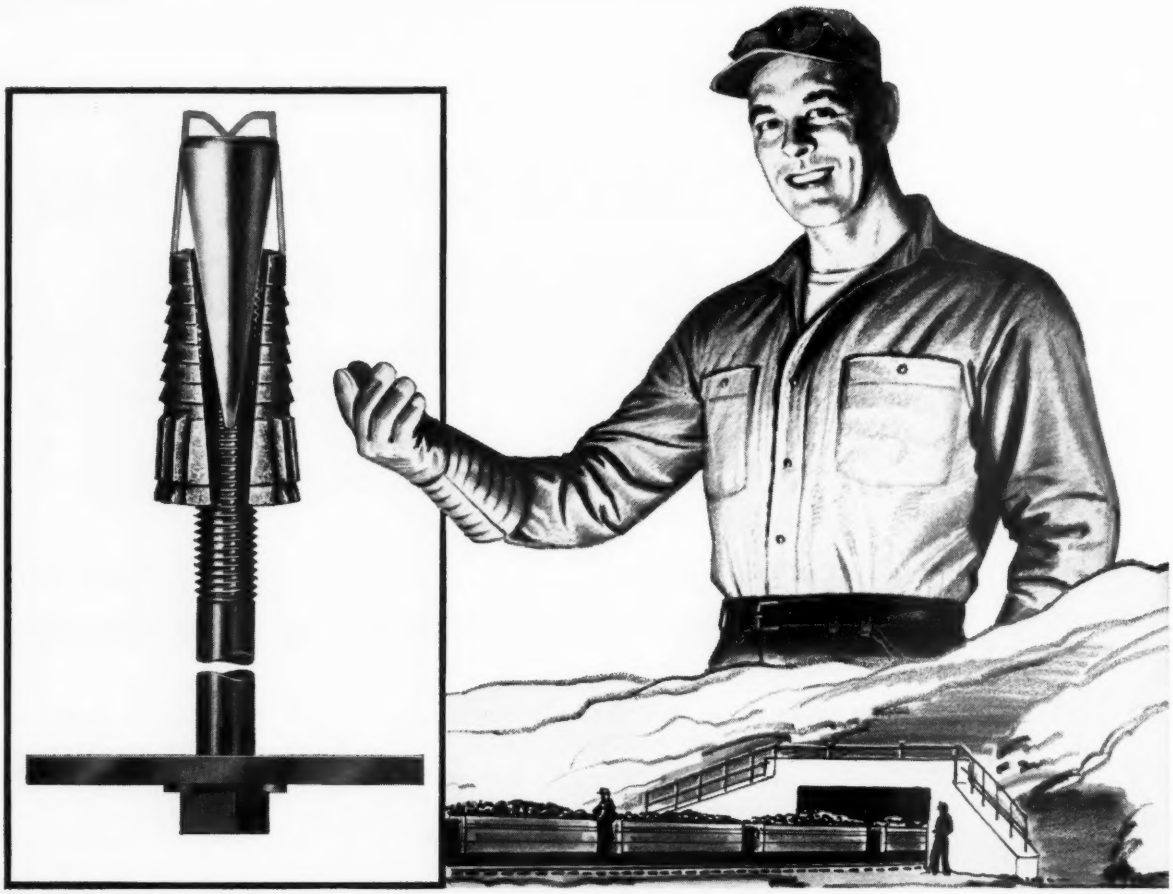
FOR **SHOVEL CABLE**



CF&I Rock Bolts with Pattin Shells give maximum anchorage

The Image of CF&I stands for a line of quality steel products that are prominent in the mining industry.

One of these—CF&I Expansion Rock Bolts with Pattin Shells—are widely used because of several exclusive design features. The double expansion of Pattin Shells gives parallel contact along the entire length of the hole, thus ensuring maximum anchorage in any type of rock. The Pattin design provides a maximum resistance to load with minimum displacement.

High strength steel—made to American Standard Specifications for roof bolting materials—provides an ample factor of safety. And CF&I Rock Bolts have been fully safety-tested, thoroughly proven in use.

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CF&I also makes a complete line of 1" Wedge Type Rock Bolts, as well as ¾" expansion type slusher pins.

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EDITORIAL

ROBERT W. VAN EVERA, Editor

JANUARY 1960

Inflation and International Gold Payments

Increasing attention in recent months has been given by the business press to the problem of the balance of payments. R. Buford Brandis, chief economist of the American Cotton Manufacturers Institute, at the First National Conference of the Trade Relations Council last October, described the trend in the United States international payments position as "clearly an economic development of the first importance," and in a recent address, Ray L. Reierson, vice president and chief economist of Bankers Trust Co., New York, said that "though no crisis is at hand, the balance of payments problem is indeed too serious to be ignored any longer."

This is a many-sided problem, and it is particularly related to the serious matter of inflation which has puzzled economic planners off and on throughout history—and more notably since 1934 when exchange for gold, the universal international monetary standard, was denied to our citizens as backing for U. S. paper currency. It is, of course, still unlawful, with minor exceptions, for Americans to own gold, and those few who can produce it at present-day high costs are required to turn it over to the United States Government at the same exchange rate, thirty-five dollars per ounce, that was set back in 1934.

According to Brandis and others participating in the recent Trade Relations Council Conference—including Franz Pick, an international monetary authority who spoke to the mining industry at the 1957 AMC Convention in Salt Lake City—the U. S. gold reserve now has a balance of $19.4 billion, $5.2 billion less than ten years ago. About $12 billion of this is mortgaged to foreign governments holding convertible dollar assets. In addition $6 billion of private foreign short-term investments exist and can be exchanged for gold in our reserves after transferring them to one of the foreign central banks. That totals about $18 billion in obligations, leaving us a cushion of about $1.4 billion—internationally.

Our monetary laws call for the treasury to maintain gold backing for our currency at 25 per cent of the outstanding banknote circulation—estimated by Pick to be an additional $8 billion required in reserve. Thus our obligations exceed our total reserves by some $6 to $7 billion.

It is fortunate that the matter isn't so direct or simple as to leave only the recourse of declaring national bankruptcy, but nevertheless corrective action is imperative.

Reierson, in the same address quoted above, said, "whereas the net balance of payments deficit averaged around $2 billion a year in the early and middle 1950's and almost disappeared in 1957, it increased to almost $3.5 billion in 1958 and is likely to be in the $4 billion range in the current year [1959]; in fact it may be above $5 billion if our contribution to the International Monetary Fund is included." This deficit is, in turn, made up of several factors, among which are our total imports from foreign countries, foreign aid, capital investment abroad, and U. S. military and defense spending abroad—to the extent that they overbalance our exports. In final summation, we are spending, giving away, or investing far more money in foreign countries than we are selling or otherwise earning in those countries. Such a trend cannot be allowed to continue much longer.

So it is more than a question of gold economics—though the importance of pure monetary policy is paramount. Also involved are such critical considerations as our domestic wage-price spiral, which is still going on and is now pricing American goods out of international markets; our tariff policies, and the foreign aid program. Domestically our Government has lived beyond its means in most of the past thirty years, and internationally we have been doing the same for nearly twenty. How are we going to reverse this trend?

Wise and reasonable guideposts to corrective action are pointed out in the American Mining Congress Declaration of Policy—published in full in the October 1959 issue of Mining Congress Journal—which covers tariffs; other matters relating to inflation such as taxation, Government expenditures, Government reorganization and labor relations; and gold, silver and monetary policy.

In the case of gold, the Mining Congress policy declaration recommends that:

"1. The restrictions on the purchase, ownership and sale of gold by United States citizens be abolished.

"2. The Administration recognize the historical and traditional confidence in gold and silver as monetary metals throughout the world, and as part of its foreign policy aid other governments in restoring gold and silver coinage—and currencies convertible into gold—as a standard of value and as a circulating medium.

"3. Congress fix the ratio at which the dollar and gold are to be made fully convertible and take all steps necessary to provide for the orderly restoration of the gold standard.

"4. The Treasury, prior to restoration of full convertibility, cease sales of gold for industrial uses."

An inspection of open pit lignite mines in West Germany reveals: (1) conveyor transportation is replacing rail haulage for coal and overburden, (2) wheel excavators range from one-man units handling 200 tph to giants capable of digging 130,000 yd per day, and (3) very high-speed flexible conveyor units have been developed and conveyor designs are rapidly being improved

GERMANY'S ANSWER to Low Cost Dirt Moving

By R. E. KENDALL

Assistant Mine Superintendent
United States Borax & Chemical Corp.

ONE of the prime objectives of mines all over the world is to move dirt at the lowest possible cost. Whether it is hoisting gold ore 6000 ft vertically in South Africa or throwing overburden 300 ft behind you in a strip coal mine in Illinois, the problem is the same —the transportation of material, which is one of the largest items of cost in mining.

United States Borax & Chemical Corp. operates an open pit borax mine at Boron, Calif. Engineering studies and cost projections show that as time goes on, conditions in the pit become continually less favorable for conventional rubber-tired haulage because of increasing depths and ever-lengthening hauls. For several years the mining staff at Boron has been studying alternate methods of excavation and transportation in order to arrive at the best possible scheme for the existing conditions.

One of the most attractive approaches to the transportation of large quantities of earth at low cost is the conveyor system. However, there are many difficulties involved. The use of conveyors in open pit mines in the United States, except for the haulage or crushed ore, is limited. Operating experience and the technical data for high-tonnage, high-speed belts is difficult to get and therefore, planning and engineering is a serious problem. Also the problem of feeding the conveyor belt, which is a continuous transportation machine, with conventional excavating equipment such as shovels, which are intermittant in operation, introduces serious objects. If material is to be hauled continuously it should be excavated continuously.

The bucket wheel excavator is one of the most attractive looking devices for feeding a conveyor, because it digs continuously and has conveyors inside it to pass material from front to rear, so connecting the two becomes a relatively simple matter.

In the open pit lignite mines of Germany a great deal has been done with wheel excavators, where they were originally developed, and with conveyors the two are being used together with great success.

What They Are Doing in Germany

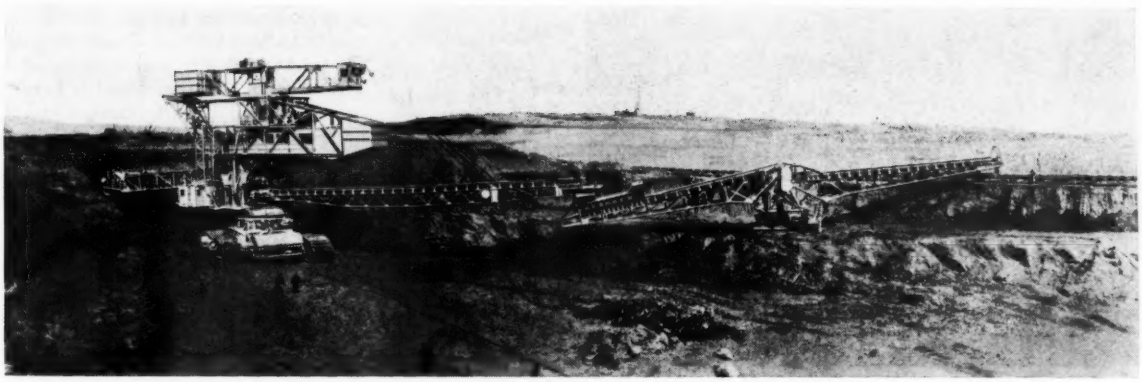
A mine inspection trip to Germany in the spring of 1959 revealed the following important facts:

(1) Conveyor belt transportation is rapidly supplanting traditional rail haulage for both coal and overburden in German pits.

(2) Wheel excavators range in size from one-man rigs with capacities of 200 tph to giants capable of digging 130,000 yd per day from a 150 ft high face.

(3) You have to throw away the book on conveyor practice. The Germans are running miles of belts at from 800 to 1200 fpm. They gave up the 20° troughing idler in favor of the 30° idler years ago and their transfer point design is constantly improving. They can move a 2000 ft long conveyor 200 ft closer to the pit face and have it running again in eight hours. Conveyors mounted on crawlers serve as a flexible link between the excavator and the belt system—flexible enough to follow a continuously moving excavator in the pit.

Germany gets most of her electric power from lignite and the open pit lignite mines are of supreme importance to the German economy. The mines are too deep and the coal too thick to dump the overburden di-



Panoramic view illustrates a typical arrangement of pit equipment for excavating and transporting overburden by means of the bucket wheel excavator and crawler-mounted as well as shiftable field belt conveyors

rectly behind the mining operation, as in our middle western strip coal fields. Mines are developed on the multiple bench system and, in that respect, are more similar to an iron ore or copper pit than they are to a strip coal operation. For this reason development of the wheel has taken different paths in Germany and America, with each borrowing ideas from the other.

American and German Wheels

The American wheel culminates in a 3500 yd per hr machine recently put into service. It is designed specifically for strip mining in that spoil is dumped directly behind the excavator by means of a long stacker boom which pivots on a common base with the digging ladder. The German machines have separate pivot points and swings for the ladder and tail boom, because the tail has to discharge into a motionless railroad car or conveyor hopper while the digging end is constantly swinging. This latter type of machine has not yet been built in the United States. The Germans are exporting considerable numbers of them and they are in use in lignite mines in Italy, Yugoslavia, India, Greece, Australia and Indonesia, in diamond fields and copper pits in Africa and in the bauxite deposits of Surinam.

For a given output, the size and weight of a wheel varies considerably with the job it must do. Hourly capacity per ton of weight means nothing unless other factors are taken into consideration, such as length of reach and digging height. A typical medium sized German excavator has a 20-ft diam wheel with eight half-yd buckets discharging at 60 buckets per min and has a service weight of 520 tons. It has a reach of 40 ft above the pit floor and 16 ft below, with a practical output of about 1300 bank yd per hour when used in conjunction with a belt conveyor system. The practical output is determined as much by the conditions of the job as by the machine itself. In general, a well designed conveyor setup will permit a 25 percent increase in output over a train haulage simply because the machine can run a greater percentage of the time.

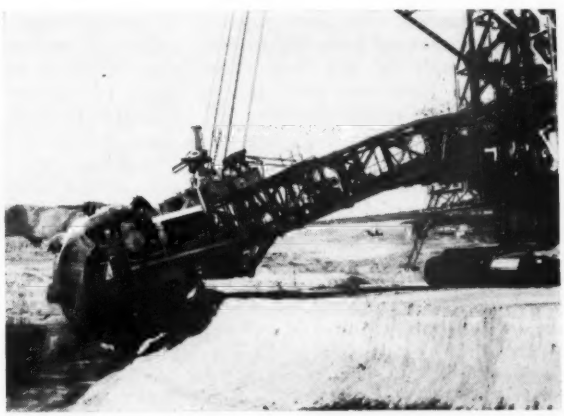
In Germany the wheels are built to the miners' specifications. One wheel working in the Rhineland can dig a bench 150 ft high and 60 ft below track level for a vertical range of 210 ft. On the larger machines the output varies between 3000 and 6000 yd per hr. In short, output to weight ratio is really a matter of the buyer's choice.

Why the Wheel?

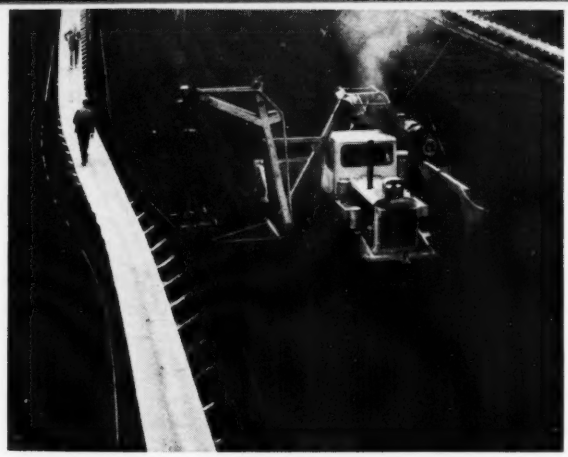
Advantages of the wheel in strip coal mining have already been proven in the United States. But what about the operator who has to haul his material? If you have a stripping or mining operation that has material that will go on a conveyor belt, and in which haulage costs are high in proportion to total costs, you should consider the wheel. They are economical excavators, but there are many other ways to dig dirt. The prime advantage of the wheel is that it makes a natural combination with conveyor belt haulage. It slices up the dirt in small pieces and delivers material continuously to the belt.

The Germans have ideal material in which to use wheel excavators; over-burden is mainly fine and sandy —easy digging. For many years the wheel was considered to be applicable only in lignite, which is soft and cuts well, but the gap between what a wheel will do and what a shovel will do is narrowing. A properly designed wheel will cut hard shale that would normally be blasted for shovel stripping and development of the chain-backed bucket has made its use possible in wet sticky clay.

Consensus of opinion is that the wheel should stay away from hard rock, except for seams up to a foot thick imbedded in soft material.



The digging end of a 2000-cu yd per hr wheel excavator is shown working below grade. Note that the buckets are reversed



The face conveyor is shifted three to six ft at a time by a side-boom-equipped tractor. A roller device is attached to a 90-lb rail which is an integral part of the conveyor frame, and the tractor moves down the conveyor line at speeds up to 12 mph, dragging the conveyor into its new position

However, the cutting force on bucket teeth is constantly being increased by the use of heavier drive motors and improved design and, if progress in the next five years equals that of the last five years, the wheel excavator will be doing many jobs considered impossible today.

Conveyor Speeds Up to 1600 FPM

The use of conveyor belts for high capacity transportation of ore and waste in German open pits got started less than ten years ago, but the progress has been tremendous in that short time. One mine with a completely portable system for handling overburden uses steel cord belts with a capacity of 15,000 tons per hr running 1000 fpm. The operators have already moved 60,000,000 tons on this belt and expect to get over 200,000,000 tons on it before it wears out.

There are two things that create a lasting impression on first seeing a German conveyor-equipped pit. The belts run fast and the conveyors are extremely flexible and easy to move. Speeds on long conveyor runs are from 800 to 1200 fpm and on stackers the speeds go up to 1600 fpm. This compares with our present practice of running belts 500 to 600 fpm, although in the last three years a few have been put into operation at 800. German engineers and operating people say the limit has not been reached yet and that the limiting factor is not the belt itself but the way material rides on it.

For a given tonnage a fast belt permits a less expensive drive, a narrower belt width, and a belt with a lower tension rating. It saves in weight and structure and in general first cost is less. On many applications, such as on a long suspended stacker boom, there is no other economical alternative. In a conveyor-equipped open pit mine, with long distances to travel and high tonnages to handle, high speed is almost a necessity in order to keep the first cost down.

High speed is not an unmixed blessing, because you can get into a lot of new troubles for which you won't find the cure in conveyor handbooks. The Germans have done a great deal of work toward making high speed belt haulage a success in their country and we should profit by their experience.

Transfer Point—Heart of System

The transfer point is the heart of the conveyor system. No effort should be spared to get as near perfect as possible transfer of material from one belt to another, and in this connection there are three things in particular to look out for:

(1) Get the free fall as low as possible.
(2) Load the belt on center and in the direction of travel.
(3) Keep skirts and chuting from rubbing on the belt.

Lowering the free fall can be done in several ways. First, get the head pulley of the feeding belt as close to the following belt as possible. On many of the new portable drives in Germany the head pulley is small and runs at idle, with no drive motor. The drives are on snub pulleys to the rear of the head section which permits the head pulley to project out in front of the main structure 15 or 20 ft with no interfering supports. The cantilevered projection is on a pin joint and with an adjustable brace the head pulley can be raised or lowered to get exactly the transfer wanted.

If this can't be done satisfactorily, a short transfer belt is put in between to break the fall and to give the proper velocity and direction for a good feed. If the material is lumpy or rocky, and impact damage might be severe, high speed roller grizzlies are sometimes used, which let fines fall through and provide a cushion for rocks which follow.

Loading characteristics of a stream of moving material varies with the quantity on the belt, and the Germans almost always put an adjustable deflector or splash plate in front of the head pulley to make the dirt fall vertically to a precise point on the next belt or feeder. This is absolutely essential on angular transfer points.

One operator in Bavaria has worked out an ingenious scheme for eliminating skirt wear. At the transfer point he put in extra troughing idlers and got the belt into a deep 50° trough. With a trough this steep chute skirts can be kept over an inch away from the belt without getting spillage or scuffing.

One thing is certain; the old style enclosed chute transfer point for a high tonnage belt is out because the least hang-up will cause a monumental spill before anyone notices it.

Unitized Idler Support Sections

Conveyors are no good in a mining operation unless they can be readily shifted to follow the progress of the work. The full value of a conveyor system is not realized until the belt runs all the way from the excavator to the loading dock or the waste dump. Present standard American conveyors are not readily adapted to do this.

The German scheme is radically different from anything seen in this country—the most striking difference is that no concrete foundations are used. All conveyor structures, including drive sections, are mounted on sleepers or steel sleds and are readily movable. Idler support frames are unitized and are about 15 ft long. Each section contains four troughing idlers and two return idlers.

The frames are set on ties and the only physical connection from one frame to the next is the rubber belt since there is a 2½-ft gap between sections. It is done to provide a non-rigid framework so that the whole structure can be shifted without dismantling and, at the same time, without warping or bending the frame. This last requirement must be satisfied in the design of a movable open pit conveyor.

2000-Ft Conveyor Shifted 200 to 300 Ft in 8 Hours

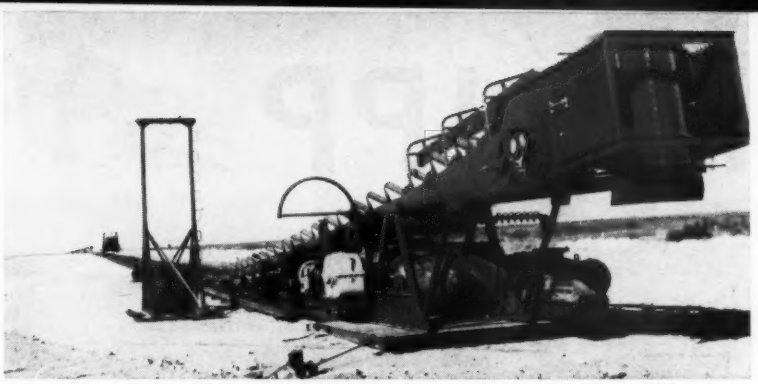
The only ground preparation required for this type of conveyor is a graded roadway. Vertical control is not too important as the conveyor runs can follow, to a great extent, the natural irregularities of the ground. Horizontal control for line is provided by an offset stake line run in with a transit. Semipermanent conveyors are set on ties only, while the shiftable conveyors in the pit and at the dump are provided with a set of 90-lb railroad rails running on the ties on either side of the conveyor structure. The rails serve a double purpose by providing a track for movable transfer stations and tripper cars and a means for shifting the conveyor.

The conveyor is shifted by a tractor, usually rubber-tired, with a side boom attachment. After a roller device is attached to one rail, the rail is picked up slightly off the ground and pulled toward the tractor. As the tractor moves down the belt run parallel to the conveyor at speeds up to 12 mph, the rail, and consequently the whole structure, is warped in an undulating motion. When the tractor reaches the end of the conveyor it simply reverses and repeats the operation in the opposite direction. Each pass shifts the whole conveyor from three to six ft and the process is repeated until the desired shift is completed. A complete conveyor 2000 ft long can be shifted 200 to 300 ft in eight hours. The Germans have simply adapted the well known technique of railroad track shifting to conveyors, but the whole secret of the operation is that the only actual bending takes place in the rail and not in the conveyor structure.

The drive and tail sections are also portable and they are mounted on sheet steel sleds. The very largest drive stations are on crawlers. The only stress on a conveyor drive is in the direction of belt pull, and this is taken care of by anchored cables, which are tightened up on geared or ratchet hand-hoists. In the constantly shifting belts at the pit face, cable holddowns at the head and tail also provide tension for the belt.

Preference for 30° Idler

The Germans use 30° troughing idlers instead of 20° which are standard in the United States. They say the 30° idler is definitely superior for high tonnage belts, since it allows a greater cross sectional load and helps keep the belt properly trained. Return idlers are of many types, from plain steel to spiral wire to rubber disc, but most operators prefer the rubber disc because wet material does not build up on them.



Shown is a portable low-head drive section on skids. Note the overhanging, nonmotorized head pulley with adjustable deflector plate. The entire unit including the conveyor can be shifted by tractors without dismantling

The German fabric conveyor belts are much the same as ours. However, although originally developed in the United States, the steel cord belt is finding more use in Germany than here. One mine has a single 48-in. belt run 6000 ft long with belting of steel cord construction to take care of the extremely high tension resulting from the 1300-hp drive. The operator who has the 15,000 tph conveyor system uses steel cord belts with no fabric in them whatever—he said that a fabric cord belt of the same strength would be so thick it would not be able to bend around anything but a giant head pulley.

Suspension idlers are an American development and they may have an important future in open pit conveying. They are particularly attractive for lumpy or rocky material where shock loads can cause damage to the belt or idler supports. This type of conveyor was developed primarily for underground mine service, where a great deal of attention has been devoted to making conveyors easily portable. However, in an underground mine the main concern is with extending the belt in-line or tearing it down and moving it, while the pit operator wants to shift it laterally without dismantling.

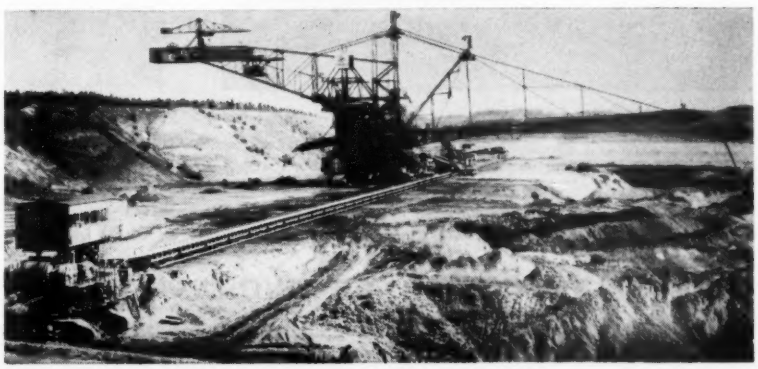
Several of the new conveying techniques, such as suspension idlers and rope belt conveyor structures, have yet to be proven in the hard competition of the high-tonnage, high-speed conveyor league.

Most New Stackers Crawler Mounted

A conveyor equipped pit is not complete without a way to get rid of waste. The German pits are too deep to backfill directly, as in strip mines, and waste hauls run from a mile up to three miles. At a new lignite pit being developed in the Rhineland, 90,000,000 tons will have to be dumped above ground before there is room in the pit for backfill.

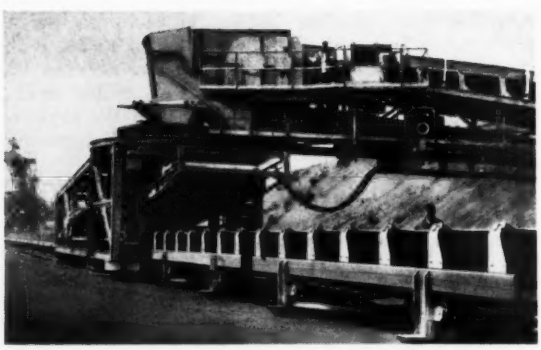
Although there are quite a few rail stackers operating, most of the new machines are crawler-mounted. The dump is just the reverse of the pit face. The dump conveyor is on ties with rails for shifting and a self-powered belt tripper rides on the rails. The stacker tail boom picks up the stream of dirt from the tripper. The highest belt speeds are found on stacker booms, to minimize weight and give the stacker extra reach by lengthening the throw. Because the material is wet and slides easily, booms are long so that the angle of inclination can be kept at a minimum.

A crawler-mounted stacker equipped with a 300-ft boom discharges 14,000 tph from an 80-in. conveyor running 1100 fpm. This unit is part of the largest excavator-belt-stacker combination in the world



KRUPP

Boom Stacker
Length of boom 110 yds.
Conveyor System
Belt width 80"
Belt speed 1125 ft./min.
Aggregate power 3150 hp



Overburden Handling System

Stripped overburden arriving by rail is discharged into a trench and reclaimed by a bucket-wheel loader. A system of movable and stationary conveyors transports the reclaimed material to a giant boom stacker which dumps it into the worked-out area. Belt tripper, boom stacker, and the drive unit of the movable conveyor are mounted on crawler tracks. Daily capacity 130,000 cu. yds. of natural soil.

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KRUPP

Bucket capacity, in cu. yd. 2.2
Maximum depth of cut, in ft. (below track level) 16
Maximum cutting height, in ft. (with different track levels) 105
Theoretical capacity cu. yd./hr. 6800/8300/10,000

Bucket capacity, in cu. yd. 4.4
Maximum depth of cut, in ft. (below track level) 16
Maximum cutting height, in ft. (with different track levels) 164
Theoretical capacity cu. yd./hr. 10,111

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on all projects involving the winning of materials and their transportation. We design complete open cast and underground mining systems and the necessary mechanical equipment on the basis of the broad experience of our mining, excavation and conveyor engineers.

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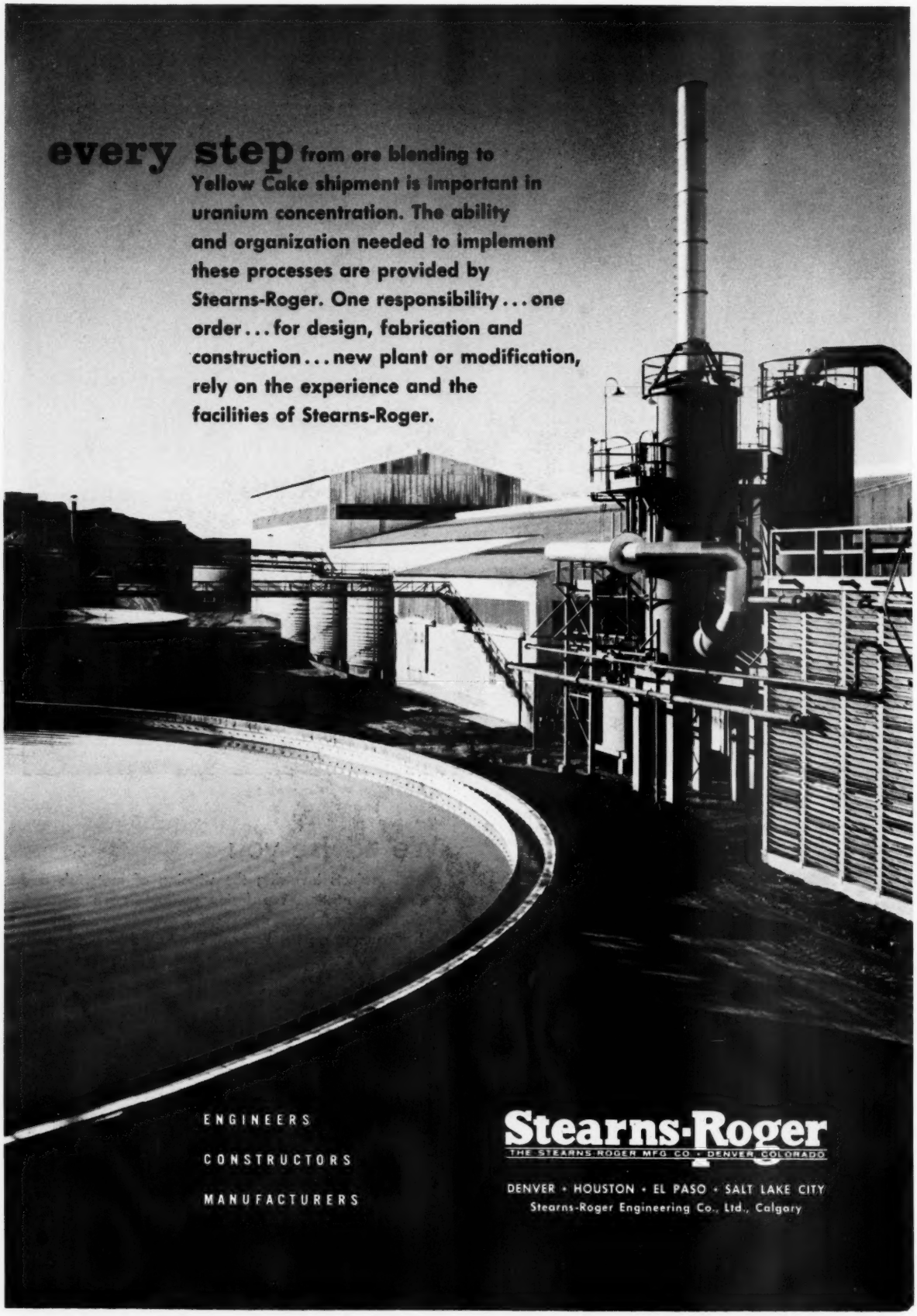
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Economic Evaluation of Proposed Mining Ventures

—concluding a series of six articles covering the subject from initial exploration work through financing the enterprise

Part V—PROCESS DEVELOPMENT AND OPERATING COSTS

By JOHN A. RIDDLE
Metallurgical Engineer
Union Carbide Nuclear Co.
Division of Union Carbide Corp.

WHEN evaluating a new project, several stages are considered in its progress from a prospect or a research project to an operating property. These are; first, a preliminary evaluation which should tell us if it is worth going to any work to develop more information; second, a more refined set of estimates after some work has been done; and third, a final complete evaluation on which a request for construction funds is based.

The stages are not usually separate and distinct, but blend one into another. As the project advances information and estimates naturally become more complete and should become more accurate. Estimates of ore reserves, capital costs and operating costs improve in accuracy from plus or minus 50 percent to plus or minus 10 percent.

Process Selection

Process selection is probably the most critical point, since it is here that the entire future of a project is determined, for better or for worse. Some of the information required before any intelligent selection may be attempted includes:

(1) Mineralogy — identification and occurrence of both ore and gangue minerals
(2) Mining characteristics—size, distribution, hardness, moisture content, ore reserves and expected range of production rates
(3) Geography — terrain, climate, labor market, transportation, availability of water, fuel, power and reagents
(4) Markets—price, volume, stability and product specifications

From this information a preliminary selection of the general treatment scheme can be made—such as concentration, hydrometallurgy, pyrometallurgy, or appropriate combinations of these. Selection would normally be followed by laboratory tests to provide a basis for further defining the process, such as choosing between tabling, jigs or heavy media separation if the ore appears amenable to gravity concentration.

If time permits and the project is large or unique enough to warrant it, pilot plant work should be done to get as much information as possible. Pilot plant studies will usually begin after the second stage of the evaluation, and may continue even after the full-scale plant goes into operation. Estimates should be revised periodically as new data becomes available. The program must be planned and carried on in a manner which will yield a maximum of information useful in the project evaluation with minimum expenditure of time and money.

Even at this preliminary state, processing economics must be considered in choosing between alternatives. Use of the term "economics," rather than cost, is important, since it encompasses sales, operating costs, capital costs, and timing. Sales relates to market conditions, to the amount of the valuable constituent recovered from the ore, and to its quality. Operating costs are important, but low operating costs do not in themselves assure a profitable operation, since it is obvious that the way to achieve lowest operating costs is to shut down.

Capital costs must be written off over the life of the project, and process selection should be done with this in mind, especially if the operating life is expected to be relatively short. Finally, the timing of the cash flows is extremely important. A dollar spent or received today is worth a dollar, but if the transaction is delayed, the dollar must be discounted according to the rate it would earn if invested. At six percent interest, for example, a dollar that will be received a year from now is worth only $0.943 today. If it will not be received for five years, it is worth only $0.747 today. Using this concept, if a $1,000,000 expenditure is made today from which no return is expected for five years, the amount paid back must be more than $1,338,689 in order for the venture to be as attractive as a hypothetical six percent investment. Discounting cash flows according to their timing is the basis for such economic criteria as discounted cash flow rate of return and present worth (See Bates and Weaver, *Chemical Week*, June 15, 1957, pp. 116–127).

The production rate should, of course, be the maximum consistent with the ore body and the market. A method we have used frequently with fair success involves making a complete estimate for a medium-sized operation, then scaling both capital and operating costs to those which might be expected at several other rates. Using these figures and such criteria as payment time, return on investment or discounted cash flow, the optimum production rate can usually be approximated by a series of trial-and-error calculations. Market conditions and forecasts of general economic conditions also must be take into account in determining the optimum rate.

Flowsheets

On the subject of the types of flowsheets and their use as a tool in process engineering, it should be noted that nothing else eliminates an impractical circuit as effectively as putting it on paper and finding that it cannot be balanced, or that it can be vastly simplified.

A variety of flowsheets are used in different stages of a project, but the most useful for preliminary evaluations is the type illustrated in figure 1. Here is the treatment scheme, material balance and the makings of an equipment list all in one piece of paper. For comparison of various treatment schemes several flowsheets will be prepared, with equipment sizes and material balances as complete as possible. From these, preliminary capital cost estimates can be prepared, and also estimates on labor, reagent and utility costs. The flowsheet should usually be prepared with soft pencil on heavy tracing paper, so that necessary changes can be made and additional information added as it becomes available. A reproducible copy can be made from the master at each stage and retained to provide a record of the evolution of the final flowsheet.

Capital Cost Estimates

Cost estimates for an evaluation are a far cry from the complete detailed estimates made later when engineering is well advanced. Contingency allowances should be generous, for projects have a way of getting more complicated and expensive during the period between initial conception and plant start-up.

First stage capital costs are frequently obtained by analogy; that is, a plant three years ago was built for $5,000,000, a new one of the same capacity should cost about $6,000,000 today. A refinement of this technique is the use of the 0.6 power of the ratio of capacities to adjust from one size plant to another. The costs should also, of course, be adjusted to present-day levels by use of an appropriate cost index. For example, if we built a 300-tpd plant in 1956 for $2,500,000 the approximate cost of a 500-tpd plant in 1959 would be:

$$(2.5 \times 10^6)\left(\frac{170}{150}\right)\left(\frac{500}{300}\right)^{0.6} = \$3{,}900{,}000,$$

where

$$\left(\frac{170}{150}\right) = \text{Nelson Refinery Index}\left(\frac{\text{June 1959}}{\text{June 1956}}\right)$$

Other cost indices such as the E.N.R. or the Marshall & Stevens Index could be used, of course. If the new plant is to be of multi-unit design, the capacity ratio might be taken directly as a cost multiplier, or perhaps to the 0.9 power instead of 0.6. These variations should be based upon analysis of previous experience, and upon the particular situation under consideration. It should be mentioned that this method can lead one far astray if an attempt is made to correlate different types of plants.

Second-round capital cost estimates are usually prepared with a flowsheet of the type shown in figure 1 by adding prices to the equipment list, and by using experience factors to go from total equipment cost to total plant cost. For instance, the cost of a plant with no unusual auxiliaries such as power plant or employes' housing may be estimated as some factor times the cost of process equipment. Factors generally range from three to four, depending on location, type of process, etc. A very good discussion by Norman G. Bach on the application of this type of factor in capital cost estimates was published in *Chemical Engineering*, (Sept. 22, 1958, pp. 155–159) and many other references may be found in the literature.

As an example of the derivation of these estimating factors, the cost of an ore treatment plant built recently is shown in table I. In this case, the process equipment cost 32 percent of the total, so the factor would be three. Table I also illustrates the relative magnitude of some of the items of indirect cost.

Incidentally, the preliminary equipment list for this plant was prepared before detailed engineering began, and a cost estimate made at this stage totaled $4,500,000. Although such close agreement is rare, it happens just often enough to be encouraging.

Operating Cost Estimates

The first-stage evaluation of a project's operating cost is usually by analogy to previous experience. That is, if a given uranium ore can be treated by acid leach and resin-in-pulp ion exchange for $10 per ton; a similar ore, which is known to consume an additional dollar's worth of acid, can probably be treated at the same tonnage rate for $11.00 per ton. This type of comparison can be broken down to operating departments and extended to similar schemes for different ores, since much of the flowsheet will be the same; crush, grind, leach, wash, discard tailings, separate and prepare

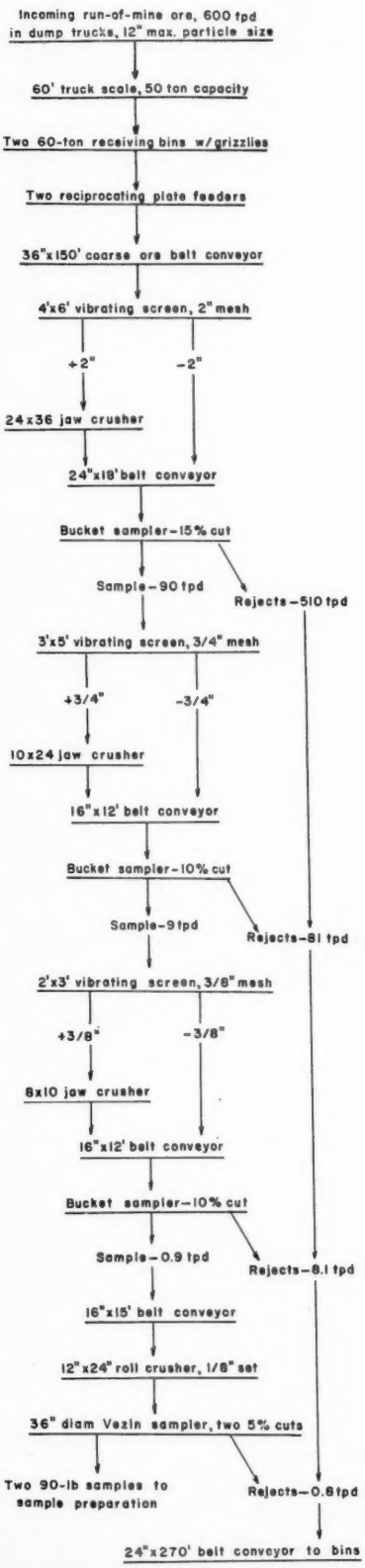

Fig. 1. Sampling plant flowsheet

Table I

Uranium Plant Cost

Item	Cost ($000)	Percent of total
Process Equipment	1,490	32
Material, equipment and buildings	379	8
Field labor	687	15
Subcontract, masonry, roofing, electrical	840	18
Freight	53	1
Sales tax	42	1
Total Direct Cost	3,491	75
Construction, tools, equipment supplies	225	
Temporary facilities	27	
Tests	2	
Field supervision	67	
Office supplies and communications	13	
Job insurance	5	
Payroll taxes and insurance	90	
Subsistence	161	
Welfare	7	
Cleanup	10	
Total indirect cost	607	13
Engineering (50 percent salaries)	360	8
Purchasing (42 percent salaries)	53	11
Contractor's fee	142	3
Total cost	$4,653	100

concentrate. For a given situation, plant throughput rate will have more effect on per-ton costs than almost any other factor.

A second stage processing cost evaluation is usually made in tabular form on the basis of direct and indirect operating costs. Direct operating costs are broken down in categories as to labor, reagents, operating supplies, maintenance supplies and utilities. In a typical break down each cost category is further broken down on a dollar per month and dollar per ton basis as to ore receiving and crushing, grinding, leaching, liquid-solid separation, product separation, and tailings disposal.

Indirect operating costs are broken down into ten major categories on a cost per month and cost per ton basis. Five categories—supervision and administration, maintenance, analytical and technical; water, air and steam; and purchasing, warehousing and accounting—are broken down as to labor and supply costs. Maintenance and water, air and steam costs also include charges for utilities. The remaining five expense categories are for payroll overhead, taxes and insurance, communications, product shipment and home office expense.

Estimates of this kind must be based on accurate cost information collected from other operations and on the best possible lab or pilot plant information as to reagent consumptions, process quantities, etc. Other forms which will be useful in developing the estimate, are hourly and salaried payroll lists, tables of reagent usages, heat balances and motor lists. It is frequently desirable to tabulate cost estimates in the form used for cost accounting in other operations, so that similar items may be conveniently cross-checked against actual experience.

A few of the factors we have found useful in preparing preliminary operating cost estimates are listed below.

Labor—Hourly, $2.00 to $2.50 per man-hour, depending on the labor market. Salaried, according to company salary scales, and list of staff personnel.

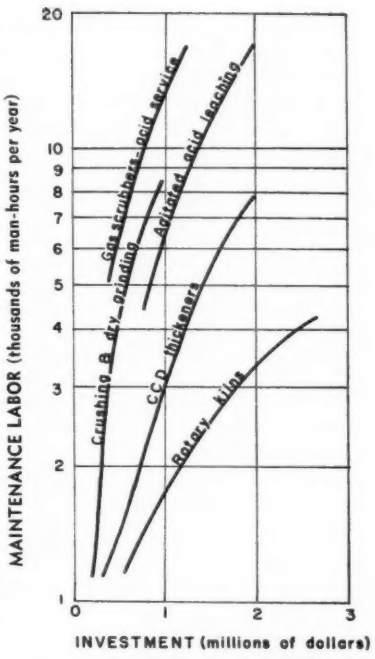

Fig. 2. Maintenance man-hours versus investment

Maintenance supplies—Annual cost one to five percent of capital cost, according to process and complexity of plant.

Maintenance labor—Equal to maintenance supplies; less if special materials of construction are used extensively.

Payroll overhead—Twelve to 16 percent of total labor, depending on the area and company policies.

Taxes and Insurance—Annual cost 1½ percent of plant capital cost. This can vary widely, depending on the area and the type of plant.

Communications—Five hundred to $2000 per month, depending on plant size and location.

One of the biggest uncertainties in

TABLE II
PRESENT WORTH COMPUTATION
(thousands of dollars)

	YEAR 0	1	2	3	4	5	6	7	8	9	10	11	12
A.													
Expenditures													
Working Capital		- 1,000											
Plant Construction	- 5,000												
Research & Dev.													
Income													
Net after Tax		+ 2,784	+ 2,784	+ 2,784	+ 2,784	+ 2,784	+ 2,784	+ 2,784	+ 2,784	+ 2,784	+ 2,784		
Depreciation		+ 500	+ 500	+ 500	+ 500	+ 500	+ 500	+ 500	+ 500	+ 500	+ 500		
Working Capital											+ 1,000		
Net Cash Flow	- 5,000	+ 2,284	+ 3,284	+ 3,284	+ 3,284	+ 3,284	+ 3,284	+ 3,284	+ 3,284	+ 3,284	+ 4,284		
Discount Factor, 6%	1.000	.971	.916	.864	.816	.769	.725	.685	.646	.609	.575	.542	.512
Present Worth	- 5,000	+ 2,218	+ 3,008	+ 2,837	+ 2,680	+ 2,525	+ 2,381	+ 2,250	+ 2,121	+ 2,000	+ 2,463		
Cumulative Present Worth	- 5,000	- 2,782	+ 226	+ 3,063	+ 5,743	+ 8,268	+ 10,649	+ 12,899	+ 15,020	+ 17,020	+ 19,483		
B.													
Expenditures													
Working Capital				- 1,000									
Plant Construction			- 8,000										
Research & Dev.	- 250	- 250											
Income													
Net after Tax				+ 3,792	+ 3,792	+ 3,792	+ 3,792	+ 3,792	+ 3,792	+ 3,792	+ 3,792	+ 3,792	+ 3,792
Depreciation				+ 800	+ 800	+ 800	+ 800	+ 800	+ 800	+ 800	+ 800	+ 800	+ 800
Working Capital													+ 1,000
Net Cash Flow	- 250	- 500	- 8,000	+ 3,592	+ 4,592	+ 4,592	+ 4,592	+ 4,592	+ 4,592	+ 4,592	+ 4,592	+ 4,592	+ 5,592
Discount Factor	1.0	.971	.916	.864	.816	.769	.725	.685	.646	.609	.575	.542	.512
Present Worth	- 250	- 243	- 7,328	+ 3,103	+ 3,747	+ 3,531	+ 3,329	+ 3,146	+ 2,966	+ 2,797	+ 2,640	+ 2,489	+ 2,863
Cumulative Present Worth	- 250	- 493	- 7,821	- 4,718	- 971	+ 2,560	+ 5,889	+ 9,035	+ 12,001	+ 14,798	+ 17,438	+ 19,927	+ 22,790

operating cost estimates is maintenance cost. Short of building the plant and operating it there is no completely accurate method of predicting maintenance costs. Engineering design, selection of equipment and quality of labor are all important but intangible variables. The relationship between capital investment, type of operation and annual maintenance man-hours has been discussed by R. L. Glauz, Jr. in *Chemical Engineering Progress* (March 1955). By using this concept, a series of graphs may be prepared using data from existing plants which will give a reasonably good basis for maintenance cost estimates. A typical graph of this type is shown in figure 2.

Typical Project Evaluation

As an illustration of a typical project evaluation consider a hypothetical project in which the exploration department has found an ore body containing 3,600,000 tons of ore with one percent metal content. The mining department advises that the ore can be mined most efficiently at a rate of 1000 tpd for a cost of $10 per ton, and a market is available for all that can be produced at a price of $2.50 per lb of metal.

Laboratory work indicates that the ore can be treated by a well-developed process that would get 75 percent recovery. It is also reported that a new scheme will probably recover 95 percent of the values, but will take about two years to develop at a cost of $500,000.

Preliminary estimates of capital cost and operation cost prepared for each case indicate that a plant using the old process will cost $5,000,000 and will operate for $10 per ton, whereas the cost of the plant using the new process will be $8,000,000 and operating cost will be $12 per ton.

Using the data given above, net income and return on investment are calculated on an annual basis as shown below:

	Case A	*Case B*
Tons of ore fed	360,000	360,000
Lb metal in feed	7,200,000	7,200,000
Recovery, percent	75%	95%
Metal recovered, lb/yr	5,400,000	6,840,000
Sales, $000	13,500	17,100
Mining cost, $000	−3,600	−3,600
Operating cost	−3,600	−4,800
Operating margin	6,300	8,700
Plant depreciation	− 500	− 800
Net before tax	5,800	7,900
Tax at 52 percent	−3,016	−4,108
Net income	2,784	3,792
Percent return on investment	56%	38%

If the only criterion is return on investment, obviously Case A is more desirable. However, a comparison of the present worth calculations shown in table II for the two cases indicates a present worth of about $22,800,000 for Case B and only about $19,500,000 for Case A. Since the present worth concept considers investment, income and timing, it is apparent that the higher present worth of Case B makes it more desirable than Case A.

A critical value in present worth computations is the discount rate used. Referring to the example, it is apparent that a higher rate would favor Case A, and conversely, a lower rate would make Case B more attractive. Selection of a discount factor is dependent on a company's capital structure, the cost of capital and the earnings from other available investment opportunities.

As pointed out in the article by Bates and Weaver, previously referred to, a complete evaluation must consider both the amount and the timing of cash flows, and present worth is an accurate and versatile criterion. Anyone interested in mineral economics would do well to spend some time exploring the effect of various factors in analyses of this type.

Part VI—COMMERCIAL BANKER'S FUNCTION IN FINANCING MINING VENTURES

By THOMAS F. CREAMER
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IN addition to venture capital by individuals and public financing and private placements carried on by underwriters through the sale of stocks and bonds, there is also a place in the mining industry for financing by commercial banks. This article will be primarily concerned with what a commercial bank looks for when financing a mining venture.

In reviewing financing figures of the mining industry since the war, the author found that the great bulk of money required for new mining ventures has come from three sources: retained earnings, sale of additional bonds and stocks to shareholders and Federal Government loans.

In the case of the Government owned Export-Import Bank, its loans have financed projects abroad for which American manufacturing companies could sell productive capital equipment. While the Export-Import Bank looks into each venture with great care and does not consider any loan for which there is not every reasonable expectation of repayment, it must be remembered that Export-Import Bank money is Government money and is not on a deposit or a demand basis such as the deposits of commercial banks. This type of financing is, however, of a special nature and the intent here is to discuss more normal financing of proposed mining ventures.

Key Factors Studied By Banker

There is basically no difference in the standards and the approach of a commercial bank in considering a loan to the mining industry than there is to the chemical industry, the heavy manufacturing industry, retail business, or even the oil indus-

try. When a bank considers making a loan, it takes the following principal factors into account:

(1) Financial position of the company —that is, current assets, current liabilities, fixed assets, long term debt and present net worth with an understanding of what is behind these figures. That last phrase is highly important. For example, inventory might be valued at $1,000,000 on the books, but the banker has to know whether the inventory is made up of material that is obsolete or otherwise less valuable in real terms.

(2) Strength and depth of company management. In other words, the confidence that any lending institution looks for in a company's management based on their reputation, experience, and know-how in their particular field.

(3) Earnings record over a period of years.

All of these factors demonstrate to the banker the proven ability of a particular company to perform successfully over a period of time and under varying economic conditions. They also indicate prospects for future profitable operations. If all is satisfactory, the banker then looks further into the specific type of financing under consideration.

The importance to a bank of an organization's proven ability to perform requires special emphasis at this point. For example, consider the case of a new chemical company and plant for which the writer's bank participated in the financing. A standard chemical plant was being built under a fixed price contract with the raw materials readily available, and apparently with a very good and committed market for the end product. Unfortunately, the management was put together as a new group to organize and run this company and, in addition, no provision was made for financial reserves to meet unexpected difficulties and added expenses. The project all but failed.

Fortunately, through injection of more funds by banks, the original underwriters and investors together with additional management strength, this situation is now turned around and the company is apparently well on the road to success. The lesson to be learned here, however, is that despite the technical features of the plant and a good market, there was not sufficient financial strength and experienced management to see the new operation through to successful completion with repayment of the loan according to the original schedule set up by the banks.

Seasonal Loans

Now let's move on to the types of bank financing. With most of a bank's money represented by demand deposits, one of the most attractive and desirable forms of commercial bank lending is the so-called seasonal loan. It typifies the classic example of the commercial bank's function.

A seasonal loan serves many needs —for example, financing a can manufacturer for the build up of inventory in anticipation of canning season, spring financing of the farmer for repayment in the fall, financing the importer for incoming merchandise to be repaid after its sale, or financing a retail store's inventory for the heavy Easter and Christmas seasons. The risks are shortest and cleanest and, therefore, smallest and evaluation by the banker is easiest. This is simply a matter of evaluating the inventory or receivables to be financed, with repayment fully anticipated and reasonably well assured within a relatively short period of time. As might be expected, such loans are the least expensive form of financing. However, it might be added, that during the sharp recession of 1958 and 1959, when prices of non-ferrous metals were depressed, the writer's bank took its share of financing heavy metal inventories carried by some of its customers. A bank is expected to do this type of financing for its long-established and good customers during such periods.

Term Loans

Seasonal, or short-term loans are not, of course, the type of financing required for a mining venture where a repayment schedule will extend over a period of years. Starting before the last war, banks, desiring to make greater use of excess loan funds entered into what are spoken of as term loans. These have an original maturity longer than one year from the effective date of the commitment. Borrowings are made under loan agreements for which the customer pays a commitment fee with the loans repayable over a period of up to five to seven years and in some cases as long as ten years. Some of the largest users of this type of bank term credit are industrial concerns in the manufacturing and mining groups.

In considering any term loan, the banker makes a careful analysis of the credit standing of the borrower, including, as mentioned before, a review of the customer's financial and operating statements and an evaluation of the company's management. This is to determine the trend of the borrower's affairs, and the borrower's potential strength and weaknesses under different and particularly under adverse conditions.

Evaluations of a mining venture are based on all available information—including reports on grade, ore reserves and recoverability as given by a competent geologist. Engineering cost estimates of the fixed or capital assets required, are studied and compared against the competence of a contractor with whom the customer might have a fixed cost contract. Mining, milling and smelting operating costs are reviewed and compared with the cost of similar operations with which the bank is familiar. All of these are either covered in a separate or combined feasibility report by engineers usually chosen by the customer, but approved in advance by the bank. Often, in addition to the feasibility report, the bank will make independent checks within the industry itself.

Finally, particular emphasis is given to cash flow figures showing estimated sources and applications of funds during the period of take down and repayment of the term loan with pro forma projected balance sheets. These essential facts, if properly presented, will show the banker and his customer the margins of safety—provided the assumptions made are reasonable after taking into account possible contingencies such as variation in sales, profit margins, cost of capital construction if not covered by a reliable fixed price contract, etc.

It is important for the banker to understand thoroughly the operations as well as the markets of his customer, so that he can evaluate fairly and realistically the assumptions and the margins of safety required in such figures as ore reserves and estimated costs of fixed assets and operations. Similarly, it is important that the borrower understand the bank's point of view and the bank's responsibilities to its depositors.

Involves Greater Risk

In addition, the banker will look at the particular company's position in an industry from a competitive standpoint, and will often call for independent engineers to report on the long term potential market for the company's end product. In the end, however, in spite of all of the expert reports furnished the bank by such competent groups, the banker must decide how much and for how long and under what terms the bank can make a loan to the applicant.

As compared to the short term seasonal loan, the term loan requires much more time and effort in reviewing and studying the particular situ-

ation, but it also involves greater risk to the lender and therefore larger margins of safety are needed. In his review of a situation the banker should look for alternative means of meeting a projected repayment schedule. In so doing, both the lender and the borrower must anticipate and discuss possible contingencies in their projections, and consider how their repayment schedule might be met in the event that the particular project does not turn out as favorably as originally anticipated. Whether we like it or not, changes will occur and margins must be provided to cover them. How many of us have ever built a house and stayed within the original estimates? I am sure that we have not always lived within the estimates in our own bank in connection with construction and remodeling—except as originally provided for by reserves or margins for unknown contingencies.

To sum up, term loans by a bank are only made where, in the opinion of the banker, the company is strong financially, well seasoned, and has demonstrated proven ability. Moreover, feasibility studies and projections of cash throw-off (this includes net income after taxes plus depreciation and depletion, after taking into account possible changes in sales volume and prices) must indicate that there is adequate cash generation to meet the repayment schedule of the loan.

Mining Costs Not Easily Determined

Some of the writer's friends, who are not familiar with the mining business, are often surprised that a commercial bank will finance or lend money based on proven oil reserves but will not do the same for a mineral deposit. There are several reasons for this. In the case of an oil reserve, once the oil has been discovered it can be more easily proved and its recoverability and cost of recovery more easily and closely estimated. Thus, it becomes a proven reserve with more immediate dollar value. Furthermore, the cost of oil recovery or production of oil from the well is relatively small; normally less than 25 percent of the final value of oil produced. Finally, the ultimate sale of the finished product is generally simpler and more assured than a mineral deposit.

In the latter case, before a pound of metal or even the concentrate is produced, a large investment must be made in mine development, equipment, and mill—all of which requires a thoroughly competent and experienced business organization. This is especially true today when very few new small mines are even considered for development because of their high costs and generally lower productivity and efficiency. Furthermore, mining costs, expressed as a percentage of the value of the end product, are not only higher than in the case of oil, but they are not nearly so exact and easily predetermined. Moreover, the metal market has shown much greater and more sudden fluctuations than the oil market. For all these reasons, it is unlikely that a commercial bank would loan any money based solely or even primarily on the value of the mineral reserve under ground with the possible exception of a coal property.

Examples of Term Loans

Over the past few years, the First National City Bank of New York has participated in a number of mining ventures—the following examples briefly describe the basis for participation:

Case 1—The subsidiary of a well established company was financed in a new mining venture. The project looked completely feasible according to the company's engineering report in which the bank had confidence. Unfortunately, in spite of a very thorough investigation ore reserves were overestimated as well as the recoverability of metal from the ore. Fortunately, for the company and the bank, their other operations are more than sufficient to repay the bank loan and leave the company in a strong financial position in spite of the loss incurred by the subsidiary.

Case 2—We are participating heavily with other banks in financing a mining venture for which the Government has given a firm contract for the end product. This is a subsidiary of a company well established with great depth of management and financial resources and which, in turn, has invested a sizable amount of its own money in the project. Originally, a thorough feasibility report on all phases of the project was submitted. The report was discussed with the engineer who made the study as well as with independent consultants used by the company in undertaking the project. The banks are convinced that the management, with its financial reserves, will see this project through to successful completion and the bank loan will be repaid on schedule.

Case 3—A uranium mine and mill is a joint effort by two companies. The parent companies—in whom we have complete faith—have agreed that the subsidiary shall maintain a minimum working capital and shall also provide sufficient cash in that working capital to meet each bank note maturity as it comes due.

Case 4—The parent company has guaranteed construction of a uranium mill at a fixed price and likewise has guaranteed the cost of mining the uranium, which with the Government purchase contract for yellowcake (final uranium oxide product) will provide sufficient cash throw-off to meet the bank repayment loan schedule.

Case 5—We, along with other banks, have financed the development of a large mining operation overseas, which is based upon the guarantee of the parent company with whom the banks have done business for years.

Case 6—Several banks, along with insurance companies for the longer portion of the term loans or funded debt, have financed development of a mine, the necessary shipping facilities, and construction of a mill and refinery. This was all based on a contract from the two parent companies, in whom we have confidence, to take or pay for the end product at a price sufficient to meet all operating expenses, including servicing of the bank debt.

Case 7—In this instance, we refinanced an RFC loan on more favorable terms to the company. Here the original project, of a venturesome nature, was of necessity financed by the Government, but once in operation we were well satisfied that the company would be able to meet the terms of the new bank loan. Actually, this turned out so well for the company that it was able to prepay the bank loan—without penalty—several years in advance of final maturity.

In all of these cases, we reviewed the program very carefully in advance and believed each would stand on its own feet. But because of the inherent risk, which must be all but eliminated for the investment of institutional funds, support from the established parent companies was not only reasonable but necessary for the additional protection of the bank's depositors.

While the examples indicate that banks have participated in financing mining ventures, the prime costs of exploration and development of many of these new properties has been carried by companies already in the mining industry. The industry has done a most outstanding job, and it is to be congratulated on its ability to increase productive capacity and to keep pace with the growing needs of this country and the world.

A centrifugal dryer was installed at the Joanne cleaning plant to reduce surface moisture of the ¼ by ¾-in. stoker coal to three percent or less. Tests indicate that the machine is successfully drying the coal to a surface moisture of 2 to 2½ percent

Centrifuging Stoker Coal

A West Virginia mine is dewatering stoker coal in centrifugal dryers to the point that it can be shipped without further drying

By E. A. WATTERS, JR.
Chief Engineer
Joanne Coal Co.

JOANNE Coal Co., owned by Sharon Steel Corp. and operated by Baton Coal Co., is mining the Pittsburgh coal seam in northern West Virginia, 12 miles west of Fairmont at Rachel. About one-third of the 5000 tpd of raw coal is mined with a "400" Goodman continuous mining machine and the balance by conventional equipment; one-third of the product is sold for metallurgical purposes and two-thirds for commercial use.

Six to Eight-Percent Moisture in Stoker Coal Poses Problem

Raw coal is crushed to five-in. top size, transported by belt to concrete storage silos, and in turn conveyed to a Link Belt jig where the entire raw coal product is washed. Refuse is withdrawn from three bucket elevators and the clean coal is dewatered and sized on two double-deck 6 by 16-ft Allis-Chalmers vibrating screens, where it is separated into ¾ by 5-in. and ¾ by ¼-in. clean coal. The No. 1 vibrator is made up of two pieces of 5/16 by 5/16-in. wire screen and two pieces of ⅜ by ⅜-in. wire screen. No. 2 vibrator is 5/16 by 5/16-in. wire screen throughout. The minus ¼-in. coal is sluiced to a drag tank and thence pumped to a Deister table plant. The clean ¼ in. by 0 is centrifugally dried in Reinvelt dryers and conveyed to two Multi-Louvre thermal dryers.

The Joanne cleaning plant was designed to convey the washed coal on two belts to an existing sizing, crushing and loading tipple apart from the cleaning plant. The ¾ by 5-in. product travels on one belt and the ¾ in. by 0 travels on the second belt. The ¼ in. by 0 heat-dried coal can be stored in the plant for three or four hours which permits the one clean coal belt to be loaded with ¼ by ¾-in. stoker coal or ¾ in. by 0 coal combined for direct loading.

This preliminary outline is necessary to acquaint the reader with the meat of the problem. In short, to ship ¼ by ¾-in. stoker coal—with as much as six to eight percent moisture after being dewatered on the vibrating screen—from November through March brought on the well-known tongue-lashing from customers because of the coal freezing in the cars. In addition the ¼ in. by 0 coal, thermally dried to an average of 3½ percent total moisture, performed the function of a sponge when the ¼ by ¾-in. stoker coal, dewatered only on a vibrating screen, was deposited on top of the heat-dried slack. Needless to say this condition provoked its share of complaints in freezing weather.

Centrifuge Installed

The ¼ by ¾-in. stoker coal constitutes about one-fourth of the total

clean coal output of the preparation plant, or a little over 100 tph. Due in a large part to the introduction of continuous mining machines underground, the conveying equipment to the thermal dryers could handle but a small part of this ¼ by ¾-in. stoker coal. Prior to the installation of the Bird-Humboldt centrifugal stoker dryer, a cut from this product of about 30 tph was fed to the fine coal conveying equipment for thermal drying, which was about all the tonnage that the conveying equipment could handle. The remaining 70 tph had to be dewatered in some manner, and because of the simplicity of installation as well as the operation cost, it was decided to install a centrifugal stoker dryer to effect the following results:

1. **To reduce the moisture in slack coal (¾ in. by 0) to improve the Btu value for pricing.**
2. **To increase sales in the winter season due to the elimination of freezing in railroad cars without further coal treatment.**
3. **To develop further markets for ¼ by ¾-in. pea stoker coal for sale at a slight premium.**

The centrifuge was installed directly over the drag tank, but not supported on it. This location allowed the effluent from the centrifuge to discharge freely into the ¼ in. by 0 clean coal drag tank. By conveying the screened ¾ by ¼-in. pea stoker coal to the centrifuge, it was possible to continue bypassing about 30 tph to the heat dryers and centrifuging the remaining 70 tph. This location permitted some form of drying on all the ¾ by ¼-in. pea stoker coal produced in the plant at the present time with the installation of one Series 1000 Bird-Humboldt oscillating screen centrifuge.

There is considerable surface moisture leaving this product before it enters the feed hopper to the centrifuge by way of a bypass for a portion of the tonnage to the heat dryers and inclined conveyor flights to the centrifuge for the remainder. The flight conveyor is on an angle of approximately 25°, permitting good drainage. In fact, the company does a fair job of drying the product before it ever gets into the dryer. Prior to this installation the ¾ by ¼-in. stoker coal was discharged directly from the end of the dewatering screen onto the heat-dried slack belt for loading.

Result—Two Percent Surface Moisture

The Bird centrifuge has been in operation over a year and to date there have been approximately 40 bulk samples taken on both the feed and the dryer product. These samples were taken periodically throughout a shift and placed in watertight containers. The total moisture and the inherent moisture were determined on each of these samples. The air dried or free surface moisture is the only moisture that is removed by centrifuging the coal product. It therefore becomes evident than an accurate determination of the percentage of the inherent moisture in a given coal is of extreme importance because the total percentage of moisture in

Passing	*Retained On*	*% Weight*
	¾" Rd.	8.3
¾"	½" Rd.	47.0
½"	⅜" Rd.	30.1
⅜"	¼" Rd.	12.8
¼" Rd.	28 Mesh	1.4
28	100 Mesh	0.2
100 Mesh	0	0.2
Total		100.0

% Total Moisture — 16.61
% Residual Moisture — 2.07
Feed to dryer
No spray on screening deck
50% from lower deck screen
50% from chute

Table I. Effect of no spray water being applied to the lower screening deck for the removal of any minus ¼-in. material

Passing	*Retained On*	*% Weight*
	¾" Rd.	8.5
¾"	½" Rd.	48.2
½"	⅜" Rd.	34.1
⅜"	¼" Rd.	7.9
¼" Rd.	28 Mesh	1.0
28	100 Mesh	0.1
100 Mesh	0	0.2
Total		100.0

% Total Moisture — 6.34
% Residual Moisture — 2.39
Feed to dryer
No spray on screening deck
50% from 20 tph chute
50% from 50 tph chute

Table II. Sampling at the discharge end of each chute from the vibrating screens after a portion has been removed to the heat dryers

Passing	*Retained On*	*% Weight*
	¾" Rd.	7.1
¾"	½" Rd.	42.5
½"	⅜" Rd.	27.5
⅜"	¼" Rd.	14.7
¼" Rd.	28 Mesh	6.8
28	100 Mesh	0.8
100 Mesh	0	0.7
Total		100.0

% Total Moisture — 4.93
% Residual Moisture — 1.87
Dryer product
No spray on feed

Table III. Analysis of dryer product when no spray water is applied to the coal at the feed end of the dryer. The feed water is intended to remove some of the fines through the basket openings and is finally discharged with the effluent. A representative feed sample to the centrifuge is believed to be: 2.39 percent residual moisture and 3.95 percent air-dry moisture, or 6.34 percent total moisture

There are various ways in which the moisture can be affected in both the feed and dryer product. Beginning with the double deck vibrating screens, spray water—either fresh water for plant make-up or recirculating water —can be applied to the ¼ by ¾-in. coal for removal of fines. The following analyses illustrate what happens

Passing	*Retained On*	*% Weight*
	¾" Rd.	8.4
¾"	½" Rd.	44.5
½"	⅜" Rd.	27.3
⅜"	¼" Rd.	12.7
¼" Rd.	28 Mesh	5.9
28	100 Mesh	0.7
100 Mesh	0	0.5
Total		100.0

% Total Moisture — 4.56
% Residual Moistures — 1.93
Dryer product
Clear water spray on feed

Table IV. About 20 gpm. of clear spray water is used at the Feed end of the dryer to reduce the amount of minus ¼-in. material in the dried product. The total moisture has been lowered about ½ percent through the use of clear spray water. From the results obtained in analyzing some 40 product samples, the following total moisture determinations is believed to be representative of the product being obtained from the centrifugal dryer: 1.93 percent residual moisture and 2.63 percent air-dry moisture, or 4.56 percent total moisture

Passing	*Retained On*	*% Weight*
	100 Mesh	36.4
100 Mesh	0	63.6
Total		100.0

Gallons per minute — 28.57
% Dry Solids — 5.31
Dryer effluent
Clear water spray on feed

Table V. Analysis of dryer effluent. Clear water spray was in service at the feed end of the dryer

the coal less the inherent moisture leaves the percentage of air dry or free surface moisture, which is the only part of the moisture in the coal that can be affected by a centrifugal coal dryer. Of course, the removal of certain fine coal increments will materially affect the total percentage of moisture in both the feed and dried coal products, and more will be said about this in discussing the effluent from the dryer.

From some 40 different results taken thus far, the company believes the following total moisture determination to be representative of the product being obtained from the Bird Humboldt centrifugal dryer:

Percent total moisture....	**4.56**
Percent residual moisture.	**1.93**
Percent air-dry moisture..	**2.63**

Machine was installed to deliver a product of three percent surface moisture or less in the ¼ by ¾-in. stoker coal. The average of the 40 product samples mentioned above is as follows:

Percent total moisture....	**4.0**
Percent residual moisture.	**2.0**
Percent air-dry moisture ..	**2.0**

The feed sample can vary considerably in total moisture, depending on the plant's screening and dewatering efficiency in obtaining the desired moisture and screen analysis in the pea stoker coal. At Joanne, the following is believed to be a representative *feed sample* to the Bird-Humboldt centrifuge:

Percent total moisture....	**6.34**
Percent residual moisture.	**2.39**
Percent air-dry moisture ..	**3.95**

Degradation of the coal in the process of centrifuging is not serious, for the results so far show the increase to be largely in the ⅛ by ¼-in. coal which will average about 5 to 6 percent increase.

Although the machine has been operating over a year, there have been no serious expenditures for repairs or down time. The only part that has been replaced is the rubber ring at the top of the bowl which prevents the coal from breaking up by beating against the steel bowl surface. Although expected screen life is about 2500 hours, the machine now has been in operation for a much longer period and the screen is still serviceable.

The Bird-Humboldt centrifugal stoker dryer will dry ¼ by ¾-in. coal to a surface moisture of 2 to 2½ percent. Total moisture will depend on the residual moisture in the coal upon which a centrifugal dryer has no effect.

The Roof Fall Problem*

Don't Try to Out-Guess Roof—Support It

The greatest danger in coal mining is, and always has been, coal or rock falling from the roof, rib or face. Year after year, falling materials injure and kill far more miners than do mine fires, explosions and flooding.

Everyone knows that blasting, electricity, or a fast-moving trip, can be mighty dangerous, but together all these have not produced as many deaths as have roof fall accidents. One-half to two-thirds of all men killed in underground coal mines met death from a fall of roof, rib or face.

The score for 1958 was 176 men killed and about 3000 men injured. Individual injuries resulted in loss of time from work ranging from a few days to several months. Many of the injured suffered permanent disabilities. Imagine the newspaper headlines all over the country if this toll had resulted from a tornado, an epidemic, or from some other catastrophe. Yet, these are the figures for one of the *safest* years in the history of the coal mining industry.

Roof falls have no respect for anyone who works underground, whether it be a mine owner, superintendent section boss, a new man working his first shift, or even an old-timer. Experience won't keep the roof off anyone's back. Mine supervisors and miners with years of experience are being injured and killed. The average experience of men killed by a fall of roof is about 22 years.

The large annual toll from roof falls can positively be reduced. Using machines, instead of hand methods, has greatly reduced exposure to the hazard. The development of roof bolting has also greatly reduced the danger, and timbering methods are improving. Although engineers have not yet been able to devise foolproof protection from roof falls, efforts are being made to find some way of providing complete protection.

Yet, thousands of coal mining people will be injured or killed unless more aggressive steps are taken to stop these accidents. For example, we can do much better with available safety tools than has been done in the past. We can adopt better timbering plans, and we can use more roof bolting wherever conditions permit. We can give more attention and emphasis to the observance of safe procedures. In case after case, such attention has resulted in stopping accidents at mines where officials and workers joined together to whip the problem.

Excellent safety records can be made by profiting from the mistakes that have caused the most frequent and serious injuries in the past. These mistakes always involved disregard of one or more of the three "T's" for self-protection from loose top—namely, Testing the roof, Taking down loose top, or Timbering weak roof.

Experience has proved that failure to test the roof by sight, hearing, and by touch, has figured in numerous roof fall accidents. In many cases, a casual *visual* examination by both supervisors and men was not enough to prevent an accident.

Probably the worst mistake being made, especially by experienced supervisors and men, is attempting to "outguess" roof which is known to be loose. In numerous reported accidents, taking down or supporting the loose area was postponed on the assumption that the roof would hold a few minutes longer—until some small task was done. Our eyes, ears, and sense of touch can only tell us where the roof may be tight or loose—not how long it will stay in place!

Systematic timbering will eliminate numerous misjudgments of roof conditions. Unfortunately, the safety effectiveness of standard support methods is not fully appreciated. Violations of standard plans figure in at least one-half of the fatalities from roof fall accidents. Responsibility for such violations often must be shared by supervisors who knew that the standard plan was not followed.

Further, good timbering systems are nullified to a great extent if safety posts are not set or replaced when making room for the operation of machines. This single dangerous practice has been a factor in about ten percent of fatal roof fall accidents.

Correction of the few outstanding errors just mentioned would be a big step toward solving the major accident problem in the coal mining industry. To help miners solve it, a "National Campaign to Prevent Injuries from Roof Falls in Coal Mines" has been started. Its goal is a 50 percent reduction in injuries from roof fall accidents during the year. To achieve this goal, everyone in the industry must join in an all-out drive to observe safe practices that will stop roof fall injuries. Your part in this campaign starts right now!

* *Prepared by the Advisory Committee, 1960 National Campaign to Prevent Injuries from Roof Falls in Coal mines.*

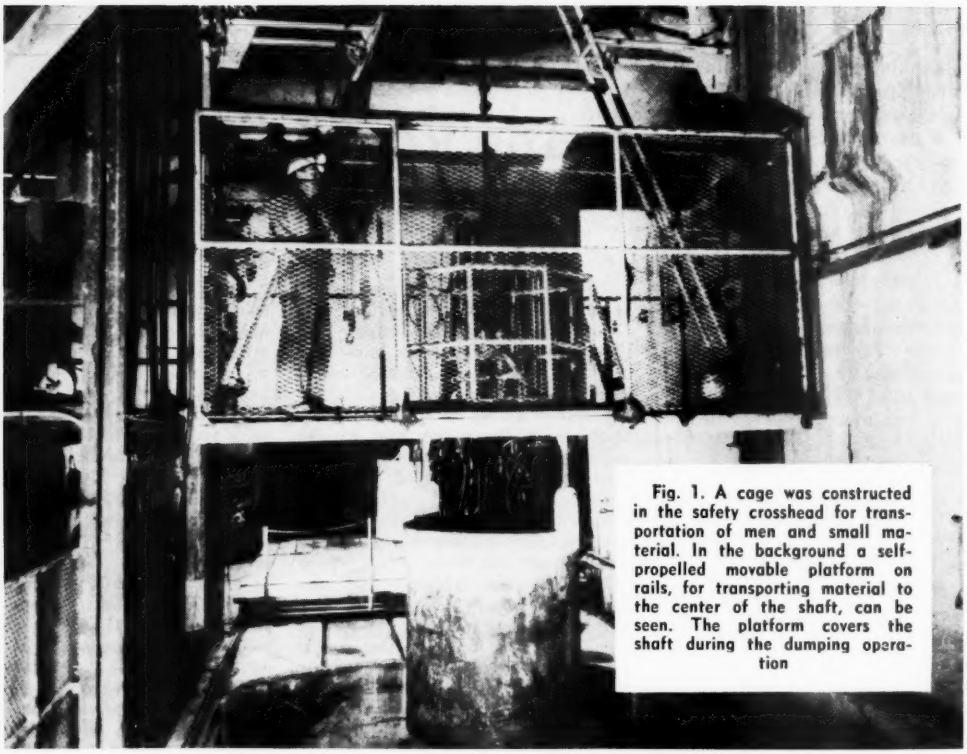

Fig. 1. A cage was constructed in the safety crosshead for transportation of men and small material. In the background a self-propelled movable platform on rails, for transporting material to the center of the shaft, can be seen. The platform covers the shaft during the dumping operation

Large Circular Underground Shaft Sinking at Climax

To maintain production of 33,000 tpd beyond 1968, long range plans call for developing new levels from a concrete lined 19-ft diam shaft. Centrally located, to take advantage of good ground conditions and quick access to all areas of the new 600 level, its ultimate depth will be 767 ft

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DURING the early 1950's, Climax Molybdenum Co. undertook an expansion program to develop the Storke level which increased production, in conjunction with the original Phillipson level, to 33,000 tpd by the latter part of 1956.

In order to maintain this high rate of production, the company's long-range planning engineers determined that a new level 300 ft below the Storke would have to be developed and be ready for production by 1968, when the Phillipson will be in the process of final depletion. The new level is to be called the 600 level.

During the development period on the 600 level, it will also be necessary to conduct a diamond drilling exploration program on a level 329 ft below the 600 level to be called the 929 level. The 929 level will later be used as a ventilation exhaust system for the future 900 production level, and, in the interim, will serve as a ground water drainage system for the block of ore between the 600 and 900 levels.

Present production from the Phillipson and Storke levels is hauled out to the crushing plant through horizontal tunnels, each approximately 3000 ft long from the edge of the ore body to the portal. Future production from lower levels will have to be hoisted to the Storke or Phillipson elevation.

Since it was imperative to get the 600 level development started at the earliest possible date, the first step was to determine the best location for a development shaft.

The Climax ore body in plan section lies roughly in the shape of a huge circle, approximately 3000 ft in diam, with a central core of submarginal material. The central core consists of granite and schist that has been replaced almost completely with silica. It is intersected by a few fault systems, but it is normally very competent rock.

Three Factors Governed Shaft Location

A shaft location inside the mine on the perimeter of the waste core, favoring the direction of the area first to be developed and serviced from the Storke level facilities, was decided on for the following reasons:

(1) Immediately after completion of the shaft, haulage drifts and ventilation drifts in the ore zone can start in all directions. Preference will be given those drifts heading to the eastern end of the ore body where production will originate on the 600 level. Access headings to the west of the shaft will be driven to meet crosscuts from the main ore production elevating system which is still in the planning stage.
(2) Competent rock in the core lends itself to safe excavation of large openings such as the hoist room, level stations and dump pockets.
(3) Although the shaft will be subject to destruction by caving action on the 600 level in future years, the time advantage gained by its location is of much greater importance.

After it was decided that the eastern perimeter of the waste core was the best location, the actual sinking site was selected by the geology department. A core drill hole on the shaft site was then sunk to verify rock conditions.

The size of the shaft was predicated on the size of development equipment used at Climax and the maximum amount of development ore to be hoisted daily. It is expected that up to nine headings (10 by 12 ft inside timber) will be driven on three levels simultaneously. Since Climax already has a well-established concreting program, a circular shaft using slip forms, and concreting as sinking progresses, proved by cost analysis to be the most economical method for the size of the shaft required.

19-Ft Diam Shaft Has 8 by 18½-Ft Cage Compartment

The cage compartment would have to be large enough to handle a 13-ton locomotive, a 10-ton ore car, a conveyor belt type mucking machine, a loaded timber flatcar, or any piece of concreting equipment without disassembling the equipment. A 19 ft diam shaft will allow a cage compartment eight ft wide and 18½ ft long, which is ample for handling any of the equipment mentioned, and by removing the cage a 20-ton locomotive can be lowered on the hoisting cable. There is also adequate room for two skip compartments, a manway, electrical and piping service compartments, ventilation pipe compartments and a cage counterweight.

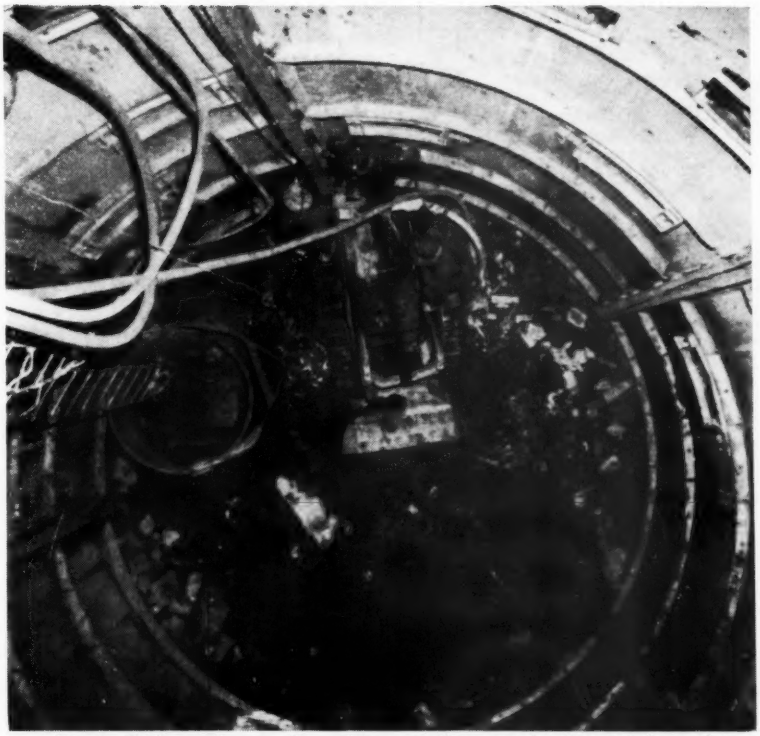


Fig. 2. Shaft mucking is done with a crawler-mounted, air-operated overshot mucker that dumps into one of two 73-cu ft buckets used during this cycle. The 19-ft diam shaft is close to the minimum size for efficient operation of the mucker.

All mining is being done by Climax supervisors and men on a straight-time three-shift basis. The job started on a six-day workweek, but reverted to five days along with the rest of the Climax operation in April 1958.

Turnouts for the shaft station and hoist room were started in April of 1957 and the shaft station was excavated with standard drifting equipment. Excavation for the hoist room, which is 110 ft long, 31 ft wide and 25 ft high, began by driving two drifts along the sides of what was to become the hoist room, and then the concrete walls were formed and poured. Arched-steel back-support sets were placed on the side walls, with only enough rock removed from the core between the parallel drifts to conveniently place the steel. After all the arched steel and back lagging was positioned, the central core was removed using a crawler-mounted mucking machine and scrapers. Muck was loaded into standard ten-ton Granby cars. Cost of excavation was $0.55 cu ft; roof support cost $0.34 per cu ft.

Exclusive Use of Steel and Concrete in Shaft Area

Raises were driven up through the ore bin location, up the center of the shaft to the headframe and up from the hoist room for cable ways to the head frame. The cable ways were completely excavated and concreted as was the headframe area where steel supports for the sheave wheels were placed in the headframe concrete. It should be mentioned that steel and concrete have been used exclusively in the shaft area for ground support. All steel was engineered to provide the correct size and shape. The shaft, from the headframe down, and the ore bin were reamed to final size and concreted to the Storke level station. The ore bin is lined with 65-lb steel rail hung on angle clip supports to prevent concrete wear in the bin and allow easy changing of worn rails.

The walls, back and floor of the Storke level shaft station were concreted. The station is 22 ft high and 22 ft wide to accommodate sinking equipment. Supports were placed in the back to aid in ground support and to hold the travel rail for six-ton electric hoists to be used during sinking operations for handling heavy

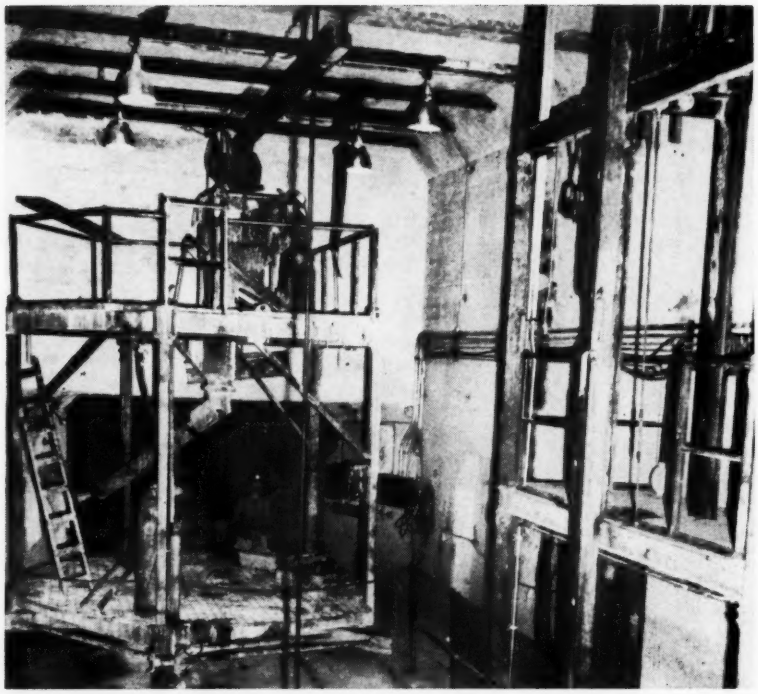


Fig. 3. The concrete work cage, with shaft steel aligning jig shown hung under the cage, serves as a distribution point for concrete dropped through a six-in. slick line. A swivel "elephant trunk" on the hopper bottom is used to place concrete behind the forms

equipment around the shaft collar, and they will serve a similar purpose after the shaft is in operation. Air and water pipe, ellectric conduit, and ventilation pipe were placed in a covered ditch so that the station would be free of entangling pipes and wires.

Two hoists occupy the hoist room. The cage hoist is an eight ft diam single drum, 600 hp d-c machine while the skip hoist is a double drum seven ft diam, 250 hp a-c machine with d-c dynamic braking. The skip hoist, which is being used for shaft sinking, has an additional 250 hp motor connected parallel to the existing motor at the opposite side of the main gear to provide sufficient power to handle shaft sinking equipment. Hoist operators' booths are soundproofed so that bell signals for one hoist will not interfere with the operation of the other hoist. The hoist room and Storke level station are lighted with mercury vapor lamps for optimum lighting conditions.

Four 3½-In. Drifters on Drill Jumbo

The drill jumbo, with air operated motors to drive the arms, mounts four 3½-in. drifters on 12-ft screw feed shells. On the bottom, the jumbo sits on a base plate where booms to the shaft wall are not required. Using three-in. carbide bits on 1¼-in. round drill steel, holes are collared and 2½-in. collar pipes are inserted to keep them clean—they are completed with two-in. carbide bits on 11 ft steels. To pull nine ft, a 68-hole round is drilled out and loaded with 1½ by 16-in. 60 percent waterproof blasting powder. Cut holes are primed with electric short period delays and regular delays are used in the outer rows of holes.

The Storke level station contains a self-propelled movable platform on rails that is used to cover the entire shaft during the dumping portion of the mucking cycle. The mucking machine, buckets, form jumbo for handling concrete forms, and general equipment are transported to the center of the shaft on that platform. The drill jumbo, when in the station, is placed on another movable platform which can be driven onto the main platform and moved to the center of the shaft for attachment to the hoisting rope. A special cutout was made for the drill jumbo so that it will be out of the shaft station proper when not in use. There is a large air receiver in the jumbo cutout for maintaining air pressure for the shaft drills.

Communication between the top and bottom of the shaft is accomplished with a standard mine phone. In most cases hoisting signals are relayed by a pull cord, but radiophone communication from a cage constructed in the safety crosshead (See fig 1) is available to communicate with the hoistman if necessary. The crosshead cage is used primarily to transport men and small material.

Each of three shaft crews consist of a shift boss, five shaftmen and a hoistman all under the direction of a shaft foreman. The shaft crew does all phases of the shaft sinking operation except for electrical and mechanical maintenance which is done by the regular mine maintenance crews. During the drilling cycle, four men operate the drills at the bottom and one man is used as top lander. About four hours are required to drill out the 68-hole round. Loading and blasting also take about four hours. Cut holes are loaded approximately one-third the depth of the hole and the rest of the holes are loaded two-thirds of the depth after which the round is wired in parallel circuit and shot from a 440-v a-c blasting line.

A blasting mat was used over the collar of the shaft until it reached a depth of 200 ft. After blasting, the fan is set on blow for 30 minutes and then the shaft and manway are checked for loose rock and the mucking cycle begins.

Overshot Mucker Operates in Close Quarters

Mucking is accomplished with a crawler-mounted, air-operated mucking machine dumping into one of two 73-cu ft buckets used during this cycle. Although a crawler-mounted overshot mucker is believed to be the best machine for this operation, a 19-ft diam shaft is close to the minimum size for its efficient operation at the bottom (see fig. 2). The mucker is very versatile, especially in station cutouts, and can be used in a variety of places after the shaft is finished.

Three men in the shaft bottom alternate between operating the mucker, placing and changing buckets and moving the pump. One man is general utility and the other man operates the dump chute and shaft door cover when the bucket is being dumped. Buckets are dumped by the conventional ball and chain method into a 250-ore bin from which the muck is loaded into mine cars through a chute with an air-operated undercut guillotine gate. It takes two shifts to muck the 90 bucket round of about 300 tons.

(*Continued on page 62*)

Methods of Reducing Operating Costs

To stay in business, a coal company must have an ever-active, well-defined program designed to exploit every available means of achieving greater productivity and lower costs

By EARL L. PETERSEN
Chief Industrial Engineer
Paul Weir Co.

SOMEONE once wisecracked that the trouble with trying to keep up with the Joneses is just about the time you catch up with them, they refinance. That could apply to some of us as individuals, but, in operating a coal mine or any other type of business, you can't just try to catch up with the business Joneses, you can't afford to just meet competition, you must be competition. The future of coal is tremendous and unlimited—the future of any individual coal company is equally so—but neither is guaranteed. A bright future can only be earned competitively.

During only the past ten years, the coal industry, through the use of more efficient methods and machinery, has improved productivity over 70 percent. That in itself is commendable, but it does little good to gloat over it. At best, such improvement should only serve as an indication that more can be done, that new and still greater progress is possible. Necessity and competition between suppliers to the industry will force the periodic introduction of new equipment, but in many cases, existing equipment can be used more effectively—right now. Today's worker, too, can be much more productive. Cost reduction is a job that is never done. To stay in business, there can only be one answer—there must be an ever active, well defined program designed to exploit every available means to greater productivity and lower costs.

Today, there are such additional management tools as market surveys, modern cost systems, inventory controls and operations research to name a few. Industrial engineers, too, because of their broad knowledge of accounting, economics, procedures, operational methods, working with people and their means for obtaining operational data and establishing realistic guides, are proving to be of inestimable value to a successful cost reduction program. However, while each of these modern tools of management has its individual worthwhile application, none of them alone can reduce costs. There are other more basic factors upon which effective cost reduction depends. An organization must possess a certain intangible quality if its programs are to produce results and have any degree of lasting success. Theory and various forms of technical guidance are very essential, of course, but the real payoff is, "are costs really being reduced?"

Objectives Should Be Spelled Out

First of all, cost reduction cannot be a hit-or-miss proposition; everyone in the organization should know what must be done and when it must be done. If, to beat competition, total costs must be reduced at least $1.00 per ton; if section unit productivity must be increased a minimum of 75 tons per shift; if haulage must be improved, or if quality is involved, spell it out specifically for all levels of management. Only then is there an opportunity to attack the over-all problem realistically and realize the full extent of the required cost reduction. Just doing a little better is usually not enough. Many firms who today are losing money and even losing customers are already doing better by past standards. Some aspects of cost reduction are even most unpleasant to perform. Nevertheless, it does little good to keep anything secret. So, if planned reductions are to take place, do not hesitate to inform the entire staff of the requirements and the measures that must be taken.

Having spelled out the specific objectives and detailed the means by which those objectives are to be realized, is, of course, only the beginning. There is always the responsibility for getting the job done. But, surely this cannot be the job of only one man. Modern experience has taught us that only with an organized team applying its combined skill and effort, can we expect maximum accomplishment. In short, there must be organization—effective organization at all levels of management.

Effective organization requires an active demonstration of leadership—that ability to get other people to work enthusiastically through the leader's influence and example. It means building an atmosphere wherein every employe feels that he is *really part of the team* and knows that his contribution is being understood and appreciated. Such organization or leadership is rarely something which just happens. It must be developed and where it exists, it usually has been developed over a period of time. It is built on a certain man-to-man relationship. It is a combination of "good human relations" and "dy-

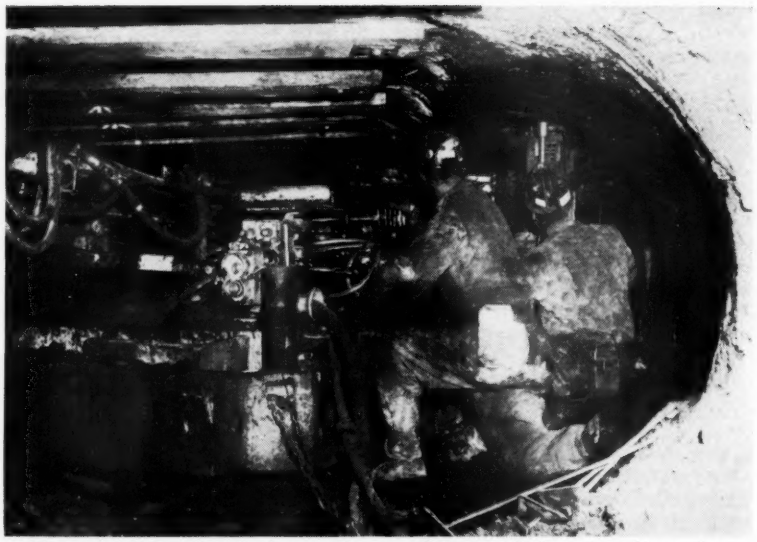
namic administration." It produces such a degree of organization discipline and respect, that things always get done.

Good Human Relations Must Start at Top

By observing the general attitude of its employes, it is not too difficult to determine any organization's relative level of productivity. You just do not get quality or quantity performance in an atmosphere of doubt and distrust. Employes are not machines and cannot be started or stopped by the mere turn of a switch. They are individuals and respond favorably only when they are recognized and treated by their superiors as individuals. Group spirit, organization morale, and the degree of cooperation are, after all, the summing up of the feeling of employes toward their supervisory—toward their company.

There is little protest with that thinking, but too often it ends at the level of the first-line supervisor. It should be expected that each such supervisor or foreman always handle his workers in a most inspiringly effective manner, Yet, many managements do not regard very seriously the manner in which they deal with him. It is said that a good supervisor is supposed to understand that difference and that he must expect certain abuse and unpleasantness as part of his job. Maybe so, but human nature being what it is, don't count on it. Foremen cannot be expected to handle workers with confidence, respect, cooperation and trust unless all *their* relationships with management are also conducted with confidence, respect, cooperation and trust. *"Good human relations" is just good business, but it must start at the top.*

Now, good human relations does not mean having an organization of all good fellows or that everything should be rosy; in fact, it had better not be just sweetness-and-light. An organization must have integrity and demonstrate understanding, but that is no reason why it should not have spine and firmness. There must be an atmosphere of friendliness, but also one of complete respect. People are often more insecure if you coddle them than if you consistently let them know where they stand and why. This obviously means disciplining them as often as may be necessary. They will take it and even like it, if they deserve it. Don't forget that whenever you coddle or give-in unnecessarily to a troublemaker, you may temporarily keep him quiet, but at the same time lose the respect of the rest of the employes. Invariably, the whole organization is helped if you make sure that such a troublemaker "gets in line" and take every action necessary to keep him in line. Each time you fail to take the proper disciplinary action, supervisory effectiveness suffers a setback. It is the fearful weak management with its ill-informed hesitant supervisors that breeds poor human relations and has trouble keeping costs under control.



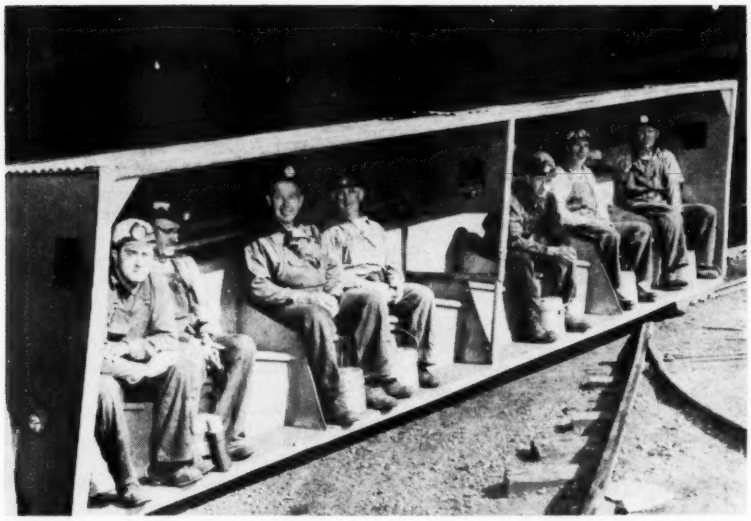
The coal industry, through the use of more efficient methods and machinery, has improved productivity over 70 percent during the past ten years

Good Performance Should Be Stressed at All Times

Whether you are a general manager, superintendent or first-line foreman, you also cannot afford to scoff at or ignore the fact that workers—and foremen too—establish images of their company and act toward the company and their supervisors more on the basis of those images than on basis of current facts and figures. Once these stereotyped notions—good, bad or indifferent—are formed in peoples' minds, they are difficult to change. Too often, managements have been guilty of accepting poor performances and certain excesses or abuses merely because volume and profit momentarily appeared ample. Then, when reduced volume wipes out or sharply reduces the profit, they expect these same matters to be corrected at once. It just doesn't work that easily. Workers—and supervisors too—find it difficult to understand why work standards, accepted for sometime as satisfactory suddenly become unacceptable. Managements should never be guilty of blowing hot one minute and cold the next. Individual performances short of the expected standards should never be tolerated, regardless of the general business level or what the P. & L. statement may show.There is no substitute for the day-by-day followup on each substandard performance, even though many of them may be relatively minor or small in consequence. This is extremely important, inasmuch as it usually is a combination of many small excesses that make up the real reason for poor productivity and high costs. Major items always command immediate attention and rarely are allowed to repeat. Therefore, if any program is to be respected and receive the proper employe support, management must be most consistent in its attitude toward all performances and in its administration of policy.

Cost reduction programs quite often associate only various technical means by which the results are to be obtained. But, *can there be any really successful cost reduction unless there is organization, effective leadership and sound human relations?*

Today's worker can be much more productive. Without a doubt, he is mentally and physically superior to past generations. Yet, considering the use of improved tools and equipment, his rate of production has not kept pace. However, it is wrong to blame the worker, it certainly is useless. The average American is a good loyal worker and inherently wants to be on a winning team, but he is suscep-



Employes are not machines and cannot be started or stopped by the mere turn of a switch. They are individuals and respond favorably only when they are recognized and treated as individuals

tible to emotions and is inclined to follow a leadership, whether it be good or bad. If worker productivity is to improve, the essential leadership must come from management. Everytime it fails to supply this leadership, the workers have little choice but to follow some other.

Expenditures Should Be Justified

Quite often, new or better equipment is assumed to be the only means to further cost reduction. There are occasions when this is the case. However, unless existing equipment is already being used to near its full potential, there is little assurance that new equipment will be permitted to provide the potential claimed for it. One general manager, known by the writer, repeatedly conveyed to his staff personnel the fact that he would always give sincere consideration to any reasonable recommendation for new equipment, provided those making the recommendation could prove the existing equipment was already being used as effectively as possible In many cases, it is such an approach that will help develop the proper comparative analyses so necessary to the consideration of new equipment purchases. Yet, that doesn't mean that a piece of equipment must be old to be replaced. It's obsolete, regardless of age, when it can be replaced, modified, or rebuilt to produce savings for the company beyond that possible under existing circumstances.

It is generally agreed that equipment being used to its maximum efficiency is always important. Yet, it can't be done with inefficient, breakdown-type maintenance. Employe productivity and equipment productivity, the two prime factors that determine the level of most all operating costs, will, to a great extent, vary strictly as the efficiency and effectiveness of maintenance varies. Yet, no other operation so essential to good performances and costs is permitted to function as blindly or is ignored more often. One reason is the fact that few coal company reports show all the excess costs that are in one way or another the result of poor maintenance as being the direct cause of such poor maintenance. In itself, *good maintenance costs less than poor maintenance.* Yet, the objective of any maintenance program should not be the cutting of maintenance costs alone. Anyone can cut maintenance costs—you need only to defer maintenance. Instead there must be a program which includes plans to attain *that level of maintenance consistent with the lowest possible product costs.*

In normal mine operation, there are certain supply costs such as those for roof support, rock dust, blasting materials and the 40 cents to the United Mine Workers of America, which on a per-ton-basis are reasonably constant, inasmuch as they occur only as coal is mined. However, except for these certain costs, *all other costs go on regardless of the production volume.* This means that for each ton of production lost, there is a total loss in income equal to the full selling price per ton minus those fixed-per-ton costs. For example, should avoidable equipment delays cause each of a mine's ten face-units to lose 50 tpd, the loss in income each day could easily total $200 per unit or a total of $2000. With such losses possible, no mine can afford to be without an effective maintenance program. While the type and size program will vary and should be tailored for individual facilities and organizations, a successful program must of all things include both "planning" and "control." Without them, no maintenance program can succeed. With these qualities, an effective maintenance program will decrease breakdowns and increase productivity; improve equipment condition and extend its working life; reduce both labor and supply costs and add to worker safety.

Another thing, most often overlooked is the adverse psychological effect that poor maintenance has upon the over-all work force. With equipment frequently down for minor repairs, men quickly lose that enthusiam so essential for attaining volume and productivity objectives. There are many occasions, when, because some piece of equipment was down for a short time or not working properly, the affected men lose all interest in the day's production. When such a delay occurs early in the shift, it is not unusual to find this attitude prevail throughout the entire shift, even though the actual delay was relatively minor. Don't forget that men possessing such an attitude produce accordingly. Too often, such instances of lost or damaged enthusiasm are another one of the many hidden causes for poor productivity and too-high costs.

Control Costs At The Source

It must always be remembered that the men who actually control costs and who are in the best position to influence their going up or down are those who directly supervise the men doing the work, operating the equipment and using the materials. They are the first-line foremen. Once they have spent a given amount of money for labor or supplies, the cost of them may be recorded in many different ways, but the money for them is gone. If savings are to be made—if costs are to be reduced—excess costs just must not occur. They must be prevented, and such prevention is almost solely dependent upon the effectiveness of the first-line foremen in the direction of his men and the use of equipment and materials.

There are some who feel that supervisory incentives or bonus plans are the answer to improved super-

(Continued on page 57)

PEACEFUL USES of NUCLEAR EXPLOSIONS

By
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Information resulting from the AEC weapons-testing program has stimulated proposals for three general applications: excavating, breaking rock in place and utilizing the heat

THE purpose of this article is to discuss the program aimed at possible use of nuclear explosives for industrial and scientific purposes, including several proposals relating to mining.

The program, now nearly two years old, has been controversial almost from the start. Those who have become interested in it appear to be divided, like all Gaul, into three parts: those who support it, for the most part zealously, like its sponsors; those who think it is hairbrained; and those who are afraid of the radiation hazards.

The program in general is known as Plowshare. The name, of course, derives from Isaiah's prophecy "and they shall beat their swords into plowshares, and their spears into pruning hooks." (Isa. 2:4.) It receives its main impulse from the Atomic Energy Commission, but many groups are collaborating—from Government, colleges and universities and industry. The list reads like a sampling of Who's Who in American scientific and industrial research. It includes, among others, the Lawrence Radiation Laboratory of the University of California, where the program was conceived, and the Rand Corp., the research group that told the Air Force in what formation a bombing mission should fly in order to safeguard the particular planes carrying bombs. It includes the Bureau of Mines and the Geological Survey, the Public Health Service, and the Weather Bureau; the University of Alaska and the Colorado School of Mines; the Westinghouse Research Laboratories and the Dow Chemical Co.

Plowshare is an offshoot of the nuclear weapons-testing program and stems particularly from a series of nuclear explosions in Nevada, in 1957 and 1958, ranging in strength from less than 100 tons of TNT equivalent to several thousand tons equivalent, and in depth from just above the surface to far enough below to contain the explosion and its radioactive effects. Four pieces of information of economic import came out of these tests: 1) a great volume of rock can be excavated if the blast is not too deeply buried, and the dimensions of the crater so produced can be controlled; 2) if the shots are deeply buried, great volumes of rock can be crushed or shattered in place; 3) a large part of the energy released by a deeply-buried shot may be retained in the rock as heat; 4) some of the rock will be melted, and when that happens much or most of the fission products released may be sealed in the molten rock.

These discoveries stimulated three general kinds of proposals: for excavation, for breaking rock in place, and for utilizing the heat. Concurently, there were also proposals for utilizing the radioactive particles produced for weather modification or control, and for scientific research in various fields.

Underground Test Shot

Before discussing the proposals themselves, it will be useful to tell something of the results of the Nevada shots and to call attention to some general considerations.

Most of the basic information on the effects of underground nuclear blasts comes from an explosion known as the Rainier shot, in which a 1.7 kiloton device was detonated 800 ft below the surface. The effects of the shot were studied by means of a number of three-in. diamond-drill holes into the blast area. From these holes it has been deduced that the blast created a cavity, or bubble, 110 ft in diam, lined with five in. of molten rock or "glass." The cavity collapsed almost immediately after formation, within a period of no more than a minute or two, yielding about 700,000 tons of crushed and broken rock, 500,000 tons crushed by the explosion itself and 200,000 tons broken by collapse. Underground workings (a raise from which a drift will be run) are now being driven to learn more about the chimney of broken rock above the blast cavity.

As previously implied, if the explosion is shallow enough it will create a crater. This it does partly by pushing the rock aside and partly by blowing it into the air, the ratio being related to the depth of the shot. A ridge is built around the crater like that around Meteor Crater in Arizona. For an explosion of given power, the radius of the crater increases with depth up to a point and then decreases.

All this information—all experience up to now on what happens when a nuclear device is exploded underground—is confined to the tuffs in which the Nevada shots were detonated. Other silica-rich rocks (sandstone, the various igneous rocks, and

the like) are expected to react similarly—for a deeply-buried shot specifically, to yield an initial cavity with some melting of the rock, followed by collapse of the cavity. Salt, and limestone or similar rock, presumably would be melted in much larger proportions, and the molten material should constitute excellent heat reservoirs.

Much to be Learned

A great deal has to be assumed. For example, knowledge of the thermodynamics of salt and lime is confined to pressures and temperatures that are quite low as compared to the millions of atmospheres of pressure and millions of degrees of temperature in the nuclear explosions, to say nothing of the instantaneousness—measured in milliseconds—with which they are reached.

Within recent months mathematicians at Lawrence Radiation Laboratory have succeeded in setting up theoretical equations that can be fed into a computer and from which they hope to be able to forecast many of the physical effects of an underground explosion. If so, this will eliminate a good deal of speculation and minimize the need for preliminary tests, such as the tests with ordinary high explosives (HE) which will be referred to later.

Throughout all these proposals there runs the question of the possible escape of fission products and consequent possible danger to man.

Fall-out Can be Contained

In the deeply buried shots, nearly all the fission products were found imprisoned in the "glass," the rest getting trapped elsewhere. In the shallow shots most of the fission products were caught in the broken rock in place. The amount of radiation fall-out depends on the amount of rock thrown into the air, which in turn, as stated above, is related to the depth of explosion, so that safety against fall-out can be secured by some sacrifice in the size of excavation.

The total amount of fission products produced is said to be small in any event; even in the worst of circumstances only a small percentage of what is produced may get into the air, to appear as fall-out. Dr. Edward Teller reported to a meeting of the Division of Earth Sciences of the National Academy of Sciences in May of this year that in due course explosion charges even "cleaner" than the present ones should be available.

R. A. Lindberg, a biologist with the University of California, reported to a gathering in San Francisco in late May that the risk is small as compared, say, to the indiscriminate use of pesticides.

Of special concern in this matter is the question of what happens when ground water percolates through the contaminated rock. Here, too, as in the thermodynamics of the problem, positive information is meager and speculative presumption abundant.

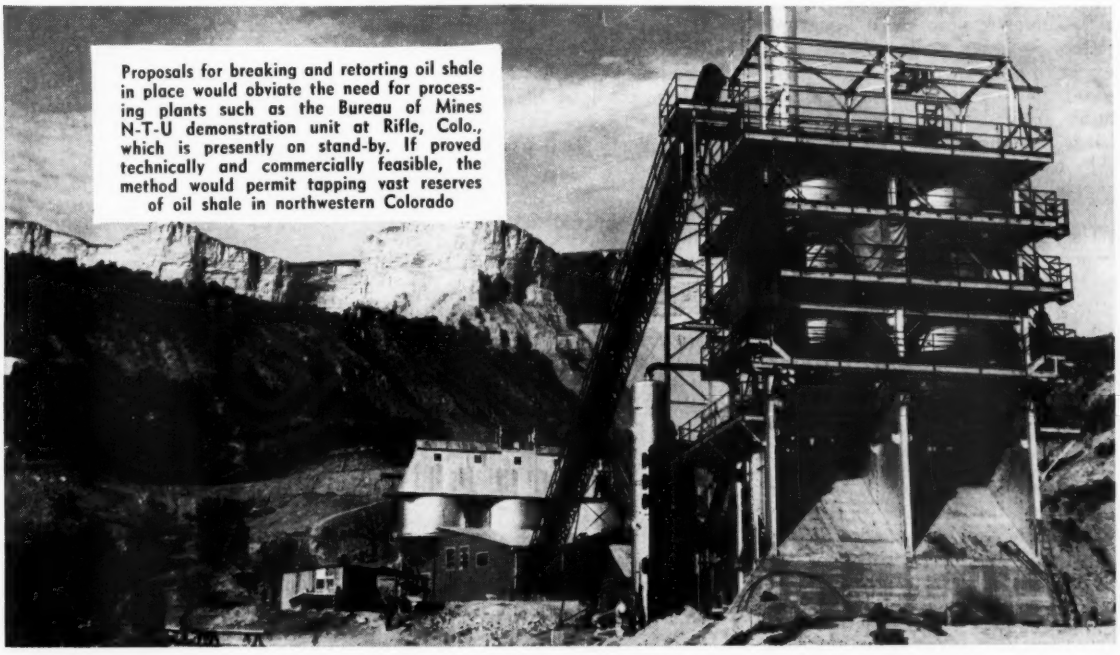
Experiments have demonstrated that fused rock, because of its insolubility, is a good container of fission products. Tests on the Rainier "glass" are reported to show that ground water having an alkalinity as high as pH10 leaches "very little" of the radioactivity out of this particular glass. Not all "glasses," however, are insoluble. Molten salt, for example, is not, nor is molten limestone. Moreover, even the "insoluble" silicate glasses deteriorate.

Water passing through contaminated broken rock will pick up some of the radioactivity, but whatever gets dissolved will presumably get thrown out of solution sooner or later by the process of base exchange as the water moves through uncontaminated rock, to get redissolved and reprecipitated in a continuous cycle. Available information is said to indicate that the radioactivity can be expected to travel only a small fraction as fast as the water itself—only a fraction of a foot per day—and thus to decay to permisible limits before it reaches a place where it may enter the biological environment.

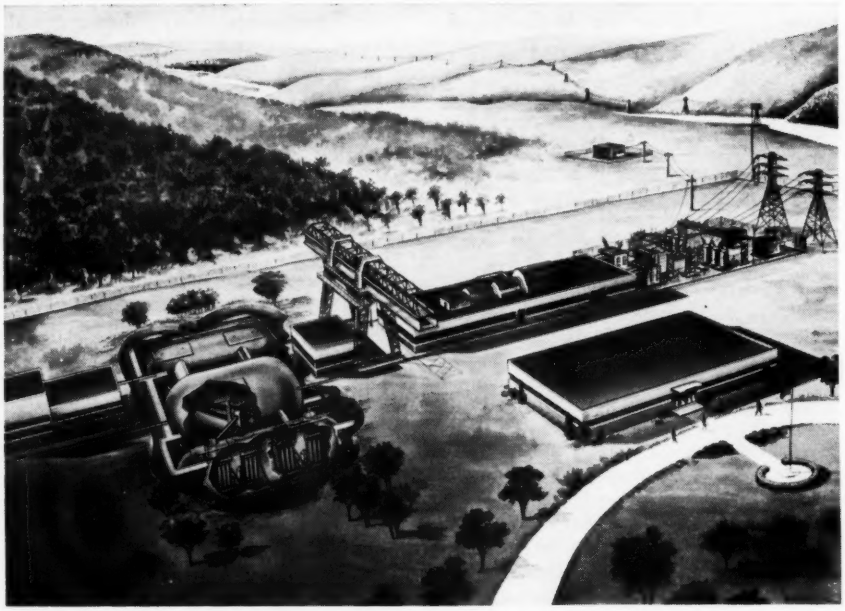
The AEC has announced that no project will be undertaken until it is satisfied that no danger exists or that the public health and safety are adequately protected.

A Harbor in Alaska

All told, a dozen or more projects have reached the point of public discussion. Some of these are designed



Proposals for breaking and retorting oil shale in place would obviate the need for processing plants such as the Bureau of Mines N-T-U demonstration unit at Rifle, Colo., which is presently on stand-by. If proved technically and commercially feasible, the method would permit tapping vast reserves of oil shale in northwestern Colorado



One advantage of developing electrical power from heat produced in a nuclear explosion would be a greatly simplified plant, completely unlike the nuclear reactor facility pictured

to take advantage of the cratering effect of a near-surface blast. The one announced first is an experiment to excavate a harbor at an isolated spot near Cape Thompson in northern Alaska. This is known as Project Chariot. A spot has been selected, the harbor has been designed, and the necessary number and size of shots have been calculated. Three 20-kiloton shots would be detonated in line at a depth of 400 ft to open the approachway from the sea, and two 200-kiloton shots at a depth of 700 ft for the turn-around basin.

Background information on ocean tides, currents, permafrost and such matters is being collected. Possible danger to life—land, sea, and human—is being looked into. Additional studies are under way. If all goes well, if it is determined that no uncontrollable hazard is involved, the shots may be detonated in 1961 and the harbor completed within a year.

The justifications given for the proposal are, one, to test the feasibility of excavating an artificial harbor by means of nuclear explosions, and two, to "open the way to the development of vast coal deposits near the coast as well as valuable oil reserves inland."

A Sea-level Canal

Another idea is for a sea-level canal across the Isthmus of Panama. The idea is that and nothing more, although a few engineering and cost calculations have been made. As may be expected—and as is true for all proposals—they are said to show that the project is both economic and technically feasible.

A third proposal to make use of the excavating power of a nuclear blast is in the stripping of thick overburden in mining operations, but this involves also the rock-breaking power of the explosion, which will be discussed later under mining applications in general.

The rock-breaking proposals include the building of underground tanks for the storage of oil, improving underground water supplies, recovering oil from oil shale, and mining.

At least the first two of these suggestions appear to be based solely on the thought: "Well, why not?" The idea is to crack up the rock where it is impervious, or—although the AEC itself is skeptical about this—to close it up where it is now porous, depending on the result desired. For example, one suggestion is to change the flow of underground water from its present course toward points where the water is more urgently needed. As I understand them, the various proposals for improving underground water supplies consist at present merely of a listing of the possibilities of breaking up the rock so as to facilitate or direct the flow of water or to permit its storage.

Oil from Shale

The purpose of the oil-shale proposal is to see if the shale would be crushed and broken in the way the tuff in the Rainier shot was broken and, if so, whether it would be made sufficiently porous to be set afire and be retorted in place.

The proposal for in situ combustion is an extension of tests being made along that line by the oil industry to see if oil sticking behind the pores of partly-drained pools can be released and driven out to peripheral wells for pumping to the surface. In the oil-shale proposal, the nuclear explosion would apply solely to creating the permeability that would be necessary. Suggestions have been made that the nuclear phase of the project be preceded by HE (high explosive) tests to learn something about how oil shale reacts to a confined explosion.

The oil shale proposal is moderately well along. It is to be conducted jointly by the Bureau of Mines and AEC but with financial participation by industry. The proposal was formally presented to industry in January of this year and a second meeting has been announced this time for the purpose of negotiating a specific agreement.

Rock Breaking—Stripping

The use of nuclear explosions in mining is conceived to be applicable under special circumstances both to the stripping of deep overburden and to the shattering of deep underground deposits too low-grade to be mined by conventional methods. In stripping operations, the nuclear explosion would be used not only to remove the overburden but also at the same time, if desired, to shatter the ore. With respect to underground deposits, broken ore would be leached in place or mined by techniques applicable to block caving.

The various proposals acknowledge the possibility of chemical

changes in the ore due to roasting or fusing, and contamination of ore by waste, all leading to possible loss of some ore and at least creating a variety of problems in subsequent ore dressing. Proponents consider such complications minor, however, as they do also the questions of monitoring for control of radiation and of appropriate ventilation to get rid of heat.

Using the Heat—Power

The foregoing proposals make use of the disruptive force of the explosion. There ought to be some way to make use also of the heat. Recall that one of the facts discovered from the Nevada shots was that a large part of the energy of an explosion is converted to heat. The initial problem is to slow down the rate of dissipation. An obvious way to do this is to store it, so to speak, in molten rock of a kind into which a lot of heat can be packed. Salt is such a rock. At the high pressures involved, salt is compacted two to three times, and heat that results from this work, as well as that required to melt the salt, is retained in it.

These considerations led to Project Gnome, a proposal to detonate a nuclear device deep in the salt beds at a site near Carlsbad, N. M. Gnome has been described as a power project, but its purpose is not to make power but to explore the mechanics of heat storage and transfer, and to determine what kind of physical environment would be produced—that is, whether the cavity would remain open (not likely), with a pool of superheated molten salt on the floor, or whether, perhaps, collapsing rubble would freeze the molten salt or otherwise create a condition that would prevent recovery of the heat. The heat would be drawn off for the production of power by passing water or some other fluid or gas through the chamber. Studies are under way to determine what "fluid" to use.

In addition, Gnome is designed to provide information on the feasibility of recovering isotopes produced in underground explosions.

Initial studies indicated that the test could be conducted without hazard to health, to potash mining or gas-well operations in the region, but as an added precaution several HE shots were detonated to make certain about the capacity of the salt to transmit seismic waves. The results were recorded by seismographs set up in the mines. The AEC has not yet reported the results.

Salt Water Distillation

It has been proposed that stored heat might also be used for distilling salt water in regions of water shortage, but up to now this has been offered only as an idea. Salt water would be piped into a deep cavity and high-temperature steam drawn off. Thermo-dynamically the idea is said to be simple enough. The proponents have calculated that, if such conversion is feasible (the qualification is theirs), the cost would be around $0.30 a thousand gallons as against four to five times that amount by other methods of distillation. The water distilled in the plant at Coalinga, Calif., for example, costs $1.45 a thousand gallons.

Other Proposals

Brief mention of a few other proposals will round the scope of Plowshare as envisioned by its enthusiasts. One idea—a sort of no limits-to-the-imagination proposal—is to produce chemicals in underground stills, retorts, or furnaces. For example, so the idea goes, calcium carbide might be manufactured at a fantastically low cost in a limestone cavern produced by a nuclear blast. The carbide could then be used to make acetyline, which could be used to make something else, which could be used to make still another product, all at such phenomenally low costs as to revolutionize chemical utilization.

Another group of proposals relates to weather modification or control. Weather control in general is not considered promising, but an idea that teases the imagination is one relating to hurricanes. Meteorologists do not consider it possible to destroy a hurricane by a nuclear blast, because great as is the power of such a blast it is small as compared with the energy in a hurricane. Some have expressed the idea, however, that hurricanes can be controlled.

A hurricane approaching land might be caused to veer back out to sea, for example, by destroying its symmetry by a blast somewhere near the periphery. Or the wind velocity, and therefore destructive power, might be lessened by blowing out the hot air in the eye of the hurricane.

Greater Potential

Perhaps this recital has led you to the conclusion that Plowshare is a hodge-podge of the practical and the visionary.

I think so myself.

Many of the proposals do seem like the direct product of a brainstorming session; some are based on extreme extrapolation from meager data, a fact that some of the sponsors readily acknowledge.

Yet I think that is all right. There is a real place for the visionary in this kind of program; in fact, it is not always easy to distinguish between what is truly visionary and what is highly imaginative but still practical.

My concern is not that some of the proposals seem to be far-fetched but with their origins. At least the mining proposals, which are the only ones I am qualified to criticize, embody curious bits of misinformation and a certain degree of what I call technologic innocence—a couple of examples will explain.

The Kennecott mine in Alaska is cited as "a possible application" (present tense), it being "covered throughout the year by sheets of ice," a fact that makes it "a very difficult and expensive mining operation because of the constant task of removing ice and snow." (This reminds me of the story of the man who was reported to have won $10,000 at the races at Hialeah, whereas in fact he lost $10 in a private game of craps at Santa Anita.) The Kennecott mine was worked out in 1938; it was an underground operation, opened by adits and inclined shafts; and the surface was not covered by snow and ice.

The stripping proposals seem to start with the idea that the stripping ratio in open-pit mining ranges from five to fifty, and the use of a nuclear device for stripping is said to be "ideal for situations such as the Anaconda-Chile operations where their waste-to-ore ratio is about ten to one." I need not comment on these figures.

Are proposals in the non-mining areas equally unprofessional? The suspicion that they may be, plus some of the general considerations described, may lead to scepticism about the program as a whole.

But Plowshare is not to be sneezed at, for all that. Radiation hazard or no, the potentialities for industrial and scientific application of nuclear explosions are too great and too exciting for active minds to ignore. The constructive utilization of this giant—the eventual fulfillment of Isaiah's prediction—is inevitable. It might be fortunate, in fact, that the radiation hazard does exist, for it is probably the one element that will keep the program's feet on the ground while its proponents' collective head remains—as it should in this case—in the clouds.

NEW THUNDERBIRD MINE USES A-C POWER

By L. E. BRISCOE

Electrical Engineer
Ayrshire Collieries Corp.

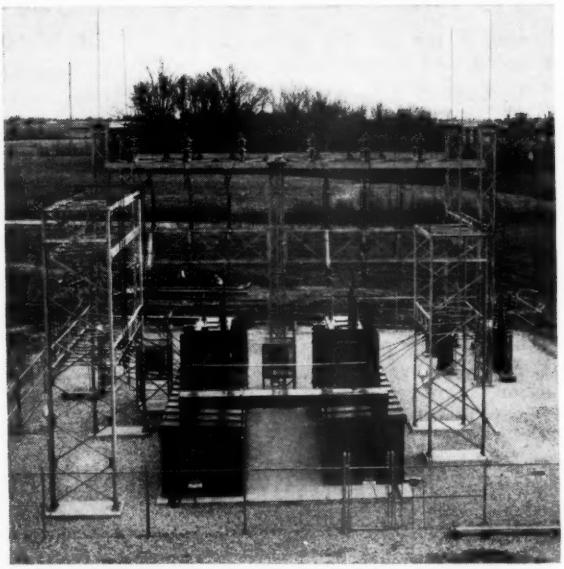


Fig. 1. Thunderbird's company-owned main surface substation consists of two duplicate transformers, each rated 2500/2125 kva force ventilated. Power is purchased from the utility company at 67 kv and transformed to 4160 volts

An electrical engineer who has been associated with the coal mining industry for well over 30 years gives some of the background behind the decision to make the Thunderbird mine all a-c power supply. He also describes in some detail the underground power distribution system, emphasizing its many safety features

THUNDERBIRD is a new mine just developed near Sullivan, Ind., by a wholly - owned subsidiary of Ayrshire Collieries Corp. of Indianapolis. This mine will supply all the coal to be used in a new generating station built by Indiana and Michigan Electric Co. on the Wabash River. The mine and power station are connected by a nine-mile spur track owned by Thunderbird.

Coal by Wire

Probably the most interesting, and certainly a highly significant feature of this mine and power station arrangement, is the untraditional arrangement of a power station located near the coal field. This eliminates shipping coal by rail to a power station located several hundred miles away near its load center. The power plant has been moved back to the mine and all its electricity will move some 200 miles by wire to customers in northern Indiana and southern Michigan. This unique arrangement results from the success of electrical power engineers in pushing the carrying capacity of transmission lines to higher voltages at greater efficiencies. The net effect is that electrical energy transmitted by wire—in this instance, 330,000 volts—has been substituted for thermal energy in coal that otherwise would move by rail. This development, coupled with knowledge to be derived from work now being done in Finland and Switzerland with transmission at 800,000 volts, presages the growth of an ultra-high voltage electrical grid system, fed by mammoth power plants located in the coal fields, interconnected with major load centers throughout large sections of the country. In this instance, for example, the power station will contain the largest single turbo-generator unit yet constructed.

The second significant element in this arrangement of mine and power plant is that each is tied to the other by a long-term fuel contract. For the power plant this contract assures a supply of fuel at a determined price for the life of the plant. For the mine this contract assures a stability of production at a constant, efficient rate. Both of these features, the large station located at mine site to serve distant customers by high voltage lines, and the long-term fuel contract, are indicative of the type of mine to be built in the future, and the conditions under which these mines will come into existence.

There are three commercial coal seams on the Thunderbird property. In descending order stratigraphically these are the No. VI, the No. V, and the No. III. Initial development is in the No. VI coal, with plans for eventual work in the lower seams. In this area the No. VI averages 64 in., with a shale roof and a firm clay floor. The mining plan is a standard Midwest panel system with no pillar recovery. Anticipated recovery is 55 percent.

Type of Face Equipment and Method of Haulage

To determine the type of power, a-c or d-c, to be used underground

for the new Thunderbird mine, several decisions had to be first established. They are as follows: (1) Type of face equipment—conventional vs. continuous mining; (2) coal transportation equipment—belt vs. rail haulage; (3) transportation of employees, face equipment, and supply material—battery powered Jeeps vs. rail haulage.

There is no need to expound on the amount of research and thinking by the Ayrshire Colleries supervisory personnel before decisions were reached on the three above pertinent items. It is only necessary to state the decisions reached and to briefly state the reasons for so doing.

Conventional Face Equipment. Because of the presence of pyrites in the Indiana No. VI coal seam, it was thought mining would be impractical with continuous mining machines. The conventional mining machines simplified the preparation plant due to the elimination of excessive amounts of fines which would have required thermal drying for the fine coal cleaning.

Belt Coal Haulage Throughout the Mine. Belt coal haulage was decided upon mainly because it was the company's opinion that a lower operating cost would be realized than if complete rail haulage, or any portion thereof, was used.

At the Thunderbird mine it was decided to use 36-in. wide panel belts with maximum length of 1500 ft; section and main belts of 42 in. width with a maximum length of 4500 ft; and transfer and slope belts of 48 in. width with proposed lengths of 300 and 1000 ft. respectively.

Battery Powered Jeeps for Transportation of Employes, Equipment and Supply Material. Ayrshire Collieries has two underground slope mines in operation. One of these, the Minnehaha mine, Fairview Collieries Corp., near Dugger, Ind., employs electric rail haulage, 250 volt d-c. Shuttle cars dump into five-ton pit cars, and electric locomotives then transport the coal to the preparation plant. The other slope operation is the Carmac mine, Carmac Coal Co., near Harrisburg, Ill. Belt haulage is used throughout. The only track in the mine is in the slope and is used for the transportation of employes, equipment, and supply material that is lowered to the bottom of the slope. Small battery powered jeeps afford means of transportation from the bottom of the slope to the face regions.

Experience at the two above named mines convinced Ayrshire Collieries that its new operation should be constructed along the design of the Carmac mine.

After making the decisions regarding the type of face equipment and method of transportation, the problem of power supply, a-c or d-c, was somewhat simplified.

Five Reasons for Choosing A-C

The application of three-phase a-c motors to underground machinery, face or off-face equipment, is by no means in its infancy. Many mine operators have looked to the use of a-c power and have successfully proven its adaptability for many or all of the applications in a mine. Formerly only d-c, 250 volt or 550-volt motors were considered. In all probability, past thinking was based on the idea that only the characteristics of the d-c series wound motor most suitably satisfied the rail haulage track motors. Application of d-c power for the haulage system blended and made advisable the use of d-c power for other face and off-face equipment motors. Many or all of these motors could have been a-c had a-c power been available. Providing rail haulage is used in a new mine today, the writer's recommendation would be a combination of a-c and d-c, preferably a combination using a-c for all face equipment.

In designing the Thunderbird mine, the final decision was to make this mine all a-c power supply for five reasons. In the writer's opinion, these reasons are listed below in the order of their importance: (1) first cost; (2) safety to shock and fire hazards; (3) maintenance; (4) flexibility; and (5) efficiency. Each of these five items will be discussed separately later.

It is common practice to deliver primary power at a relatively high voltage underground to stationary or portable substations or to conversion equipment. At such locations, the power supply is transformed or converted to a voltage permitted by state laws either a-c or d-c for mobile equipment. In other words, primary power distribution equipment for either an a-c or d-c powered mine is similar. In all probability initial cost would be comparable.

First Cost. Extensive cost calculations were prepared for Thunderbird mine in the event all equipment was powered by a-c. Similar calculations were prepared for a mine powered by d-c. In either case, the primary power was assumed to be 4160 volts, 3 phase, 60 cycles. Belt conveyors with a-c motors were considered a must in either case and would be used throughout for coal haulage. The main surface substation was to be equipped with automatic voltage regulation underload. The low voltage power distribution for the calculations were assumed to be 480 volts for a-c mine power, 275 to 300 volts d-c for the d-c mine power. Sufficient copper in both the high voltage and low voltage power distribution systems was allowed in order to have proper voltage regulation at the face equipment motor terminals. Each system was designed to afford maximum safety protection to employees and was to be equipped and installed in accordance with the Federal Bureau of Mines Safety Code. No credit was assumed for face equipment to be purchased by there being a-c instead of d-c. The comparison of the two installations showed the cost of the d-c power supply would be 33-1/3 percent to 43 percent greater than for the a-c power supply. It is not difficult to see why this is possible. You need only to compare manufacturers price lists of motors, control, and required portable cables. Last but not least, price comparisons of mobile 300 kva substations with the 300 kw rectifier will be convincing.

Safety From Shock and Fire Hazards. The author has been associated with the coal mining industry for well over 30 years either in the manufacture of shovels and draglines as an electrical engineer, or directly employed by a coal mining company. Most of this time has been spent in strip mining. He was among the first in the coal industry to recognize the need for safety built into the high voltage power distribution systems for either a strip or underground mine.

In his early visits to many mines throughout the United States an unbelievable number of electrical fatalities were heard of in the coal mining industry. Electric a-c fatalities, when caused by ground potential, line-to-ground insulation failure, should never occur, and if you are in compliance with the Federal Mine Safety Code for Bituminous Coal and Lignite Mines of the United States (Part II—Strip Mines. Article VI. Electricity, Section 5c, Subject: Grounding), they will not occur. This Section reads as follows: "In all alternating current powered systems where the line-to-ground voltage exceeds 150 volts, the system shall be grounded through a suitable impedance at the transformer station and a ground conductor circuited be-

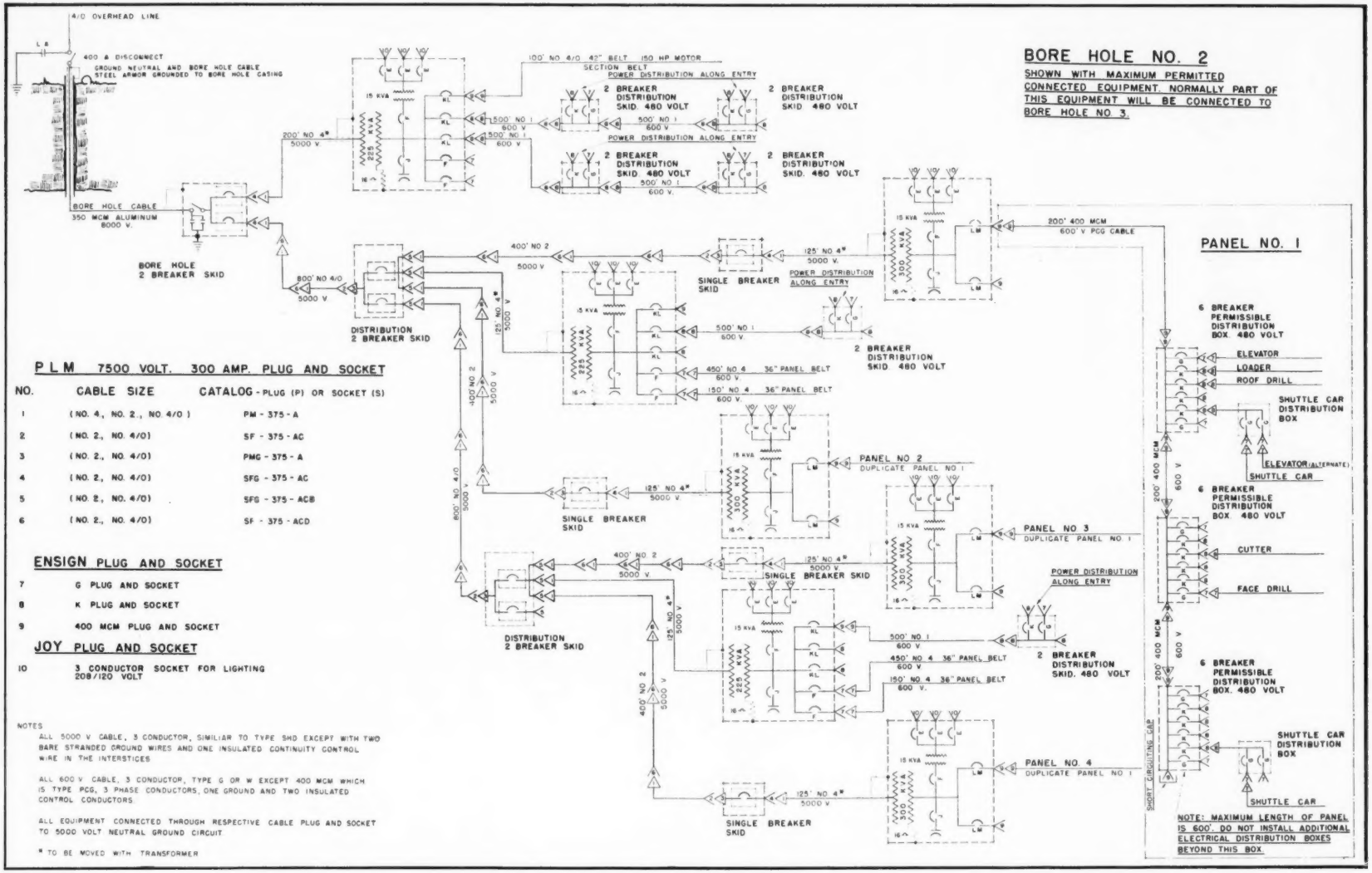
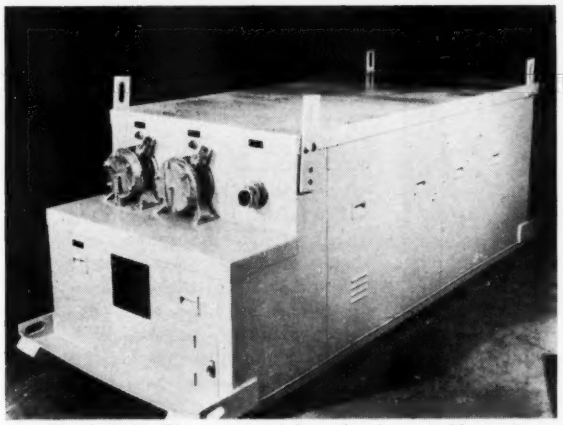

4/0 OVERHEAD LINE
400 A DISCONNECT
GROUND NEUTRAL AND BORE HOLE CABLE STEEL ARMOR GROUNDED TO BORE HOLE CASING
BORE HOLE CABLE 350 MCM ALUMINUM 8000 V.
BORE HOLE 2 BREAKER SKID
200' NO 4* 5000 V.
800' NO 4/0 5000 V.
DISTRIBUTION 2 BREAKER SKID
100' NO 4/0 42" BELT 150 HP MOTOR
SECTION BELT
POWER DISTRIBUTION ALONG ENTRY
2 BREAKER DISTRIBUTION SKID 480 VOLT
500' NO 1 600 V.
1500' NO 1 600 V.
400' NO 2 5000 V.
125' NO 4* 5000 V.
SINGLE BREAKER SKID
POWER DISTRIBUTION ALONG ENTRY
450' NO 4 36" PANEL BELT 600 V.
150' NO 4 36" PANEL BELT 600 V.
PANEL NO 2 DUPLICATE PANEL NO 1
PANEL NO 3 DUPLICATE PANEL NO 1
PANEL NO 4 DUPLICATE PANEL NO 1
200' 400 MCM 600 V PCG CABLE
PANEL NO. 1
6 BREAKER PERMISSIBLE DISTRIBUTION BOX 480 VOLT
ELEVATOR
LOADER
ROOF DRILL
SHUTTLE CAR DISTRIBUTION BOX
ELEVATOR (ALTERNATE)
SHUTTLE CAR
CUTTER
FACE DRILL
SHORT CIRCUITING CAP
NOTE: MAXIMUM LENGTH OF PANEL IS 600'. DO NOT INSTALL ADDITIONAL ELECTRICAL DISTRIBUTION BOXES BEYOND THIS BOX
BORE HOLE NO. 2
SHOWN WITH MAXIMUM PERMITTED CONNECTED EQUIPMENT. NORMALLY PART OF THIS EQUIPMENT WILL BE CONNECTED TO BORE HOLE NO 3.
P L M 7500 VOLT. 300 AMP. PLUG AND SOCKET
NO. CABLE SIZE CATALOG - PLUG (P) OR SOCKET (S)
1 (NO. 4., NO. 2., NO 4/0) PM - 375 - A
2 (NO. 2., NO. 4/0) SF - 375 - AC
3 (NO. 2., NO. 4/0) PMG - 375 - A
4 (NO. 2., NO. 4/0) SFG - 375 - AC
5 (NO. 2., NO. 4/0) SFG - 375 - ACB
6 (NO. 2., NO. 4/0) SF - 375 - ACD
ENSIGN PLUG AND SOCKET
7 G PLUG AND SOCKET
8 K PLUG AND SOCKET
9 400 MCM PLUG AND SOCKET
JOY PLUG AND SOCKET
10 3 CONDUCTOR SOCKET FOR LIGHTING 208/120 VOLT
NOTES
ALL 5000 V. CABLE, 3 CONDUCTOR, SIMILIAR TO TYPE SHD EXCEPT WITH TWO BARE STRANDED GROUND WIRES AND ONE INSULATED CONTINUITY CONTROL WIRE IN THE INTERSTICES
ALL 600 V. CABLE, 3 CONDUCTOR, TYPE G OR W EXCEPT 400 MCM WHICH IS TYPE PCG, 3 PHASE CONDUCTORS, ONE GROUND AND TWO INSULATED CONTROL CONDUCTORS.
ALL EQUIPMENT CONNECTED THROUGH RESPECTIVE CABLE PLUG AND SOCKET TO 5000 VOLT NEUTRAL GROUND CIRCUIT
* TO BE MOVED WITH TRANSFORMER

Fig. 2. Original underground power distribution system for bore hole No. 2. Note that the borehole cable is steel-armored, 350 MCM aluminum, 8000-volt cable. This type was used in order to afford better protection to the cable and to afford greater factors of safety against insulation failure within the cable in the borehole



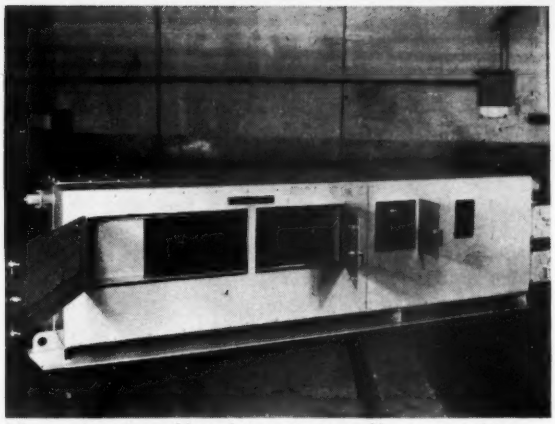


Fig. 3 (Left). The underground two-breaker switchhouse is arranged for one incoming cable and two outgoing cables connected to the multiple coupler sockets. Weight of this drip-proof breaker skid is approximately 5000 lb and its over-all dimensions are 128 in. long, 48 in. wide, and 43 in. high. Fig. 4 (Right). A 300-kva mine power center with the breaker compartment doors open. Both the power centers and breaker skids are reinforced to withstand impact damage from beyond normal roof fall

tween the impedance and the electrical equipment. A relay shall be provided to trip the circuit upon the occurrence of an electrical fault."

First it should be noted that no scheme of protection has yet been devised which will protect the individual when the person makes direct contact with a live conductor either a-c or d-c. The author has yet to learn of a fatality resulting from the ground fault on an a-c, 3-phase, power distribution system, either 220 or 6900 volts, where the ground fault protective system was in proper operation. The safety ground fault resistor or impedance limits the single line-to-ground fault current, thus limiting the maximum frame-to-ground voltage to a safe value during ground fault. The limiting of ground fault currents to relatively low values minimizes the intensity of the arc during ground fault and helps prevent mine fires.

Power distribution cables for an a-c power system, 600 volts up to 6900 volts, may be purchased which for all practical purposes eliminates line-to-line faults. A grounded sheath around the individual conductor prevents such a fault as the line voltage must first come in contact with the ground conductor.

Three-phase, a-c power presents the great advantages of a fast, sensitive, selective tripping and protective relaying system. It is most difficult to obtain all this protection in a d-c system.

Maintenance. Simplicity in design and rugged construction of the present a-c squirrel cage motor and its respective control for mining equipment can only result in reducing maintenance. You need only to think of the preventive maintenance program advisable when using d-c motors and control. The characteristics of the a-c motor permits the control to be very simple. The usual method for starting the face or off-face region motors is by cross-the-line magnetic starters. A single magnetic contactor per motor is all that is usually necessary. The use of an individual breaker and overload relays provide the required overload safety protection to the respective motor.

Portable mining machine cables protected by instantaneous ground fault tripping at the distribution box definitely will reduce cable repairs. The principal disadvantage of the a-c equipped face equipment is the actual finding of the location of a fault within the cable. Frequently the fault occurs and does not make itself visible in the outward appearance of the cable. Therefore, the location of the cable fault may result in increased down time. This disadvantage can be remedied and down time greatly reduced by the use of a fault finder in locating the cable fault. Spare cables with couplers that can be quickly exchanged with defective cable may be the correct solution of this disadvantage of locating cable faults within the cable. Ground fault within the damaged cable when removed from the equipment may then be located without additional loss of time of the unit. A distinct advantage in the use of a-c motors is the material cost for replacement parts. Practically all a-c motor failures are break-down in insulation of the stator windings or the mechanical failure of the rotor such as a broken shaft or bearings.

Flexibility. Higher voltage, three-phase a-c permits the use of smaller cables, thereby lessening not only the cable cost, but also the ease in handling. The phase current on a three-phase, a-c system at the same voltage and load is considerably less than for a d-c circuit. Therefore, the same load using the same size conductor permits power to be transmitted a considerably greater distance. This simplifies the moving of the power centers.

The mobility of the three-phase, a-c power centers permits continuously maintaining satisfactory terminal voltage on the face equipment motors. It is theoretically impossible with necessary protective equipment to burn up an a-c motor or its cable due to low voltage. Reduction in voltage reduces the output torque of the motor directly as the square of the voltage. When extreme low voltage and high torque occurs, the motor will stall and will remain stalled until the load is reduced or protective equipment removes it from its source of power.

Efficiency. Both the a-c and d-c motor and control operate at comparable efficiencies at full load. There is considerable disadvantage in the efficiency of conversion equipment with that of the transformer. The motor-generator set operates from 25 percent to 125 percent load in order of 73 percent to 87 percent respectively, that of the rectifier 90 percent to 91 percent while that of the ordinary a-c power center is approximately 97 percent throughout this load range. The increased efficiency of the transformer and maintenance of a satisfactory face voltage will result in better operation efficiency throughout the torque and voltage range of the face unit in question.

Power Distribution System

Surface Substation. The main surface substation at Thunderbird mine, which is company owned, consists of two duplicate transformers each rated 2500/3125 kva force ventilated. Power is purchased from the utility company at 67 kv and transformed to 4160 volts. The transformers are supplied with 32 step

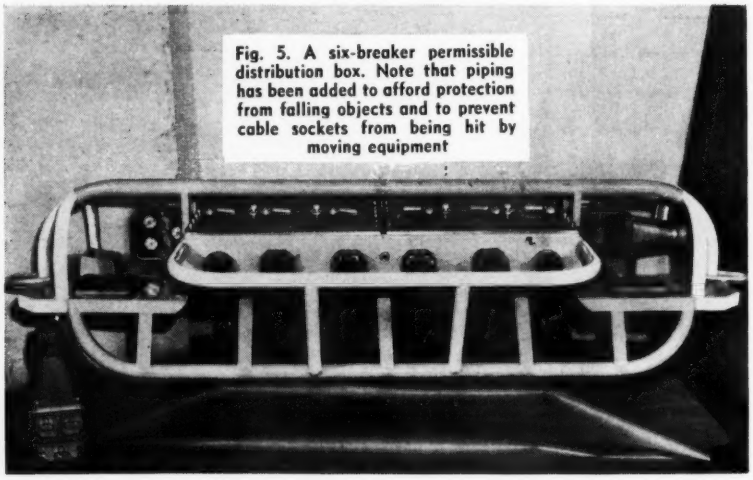


Fig. 5. A six-breaker permissible distribution box. Note that piping has been added to afford protection from falling objects and to prevent cable sockets from being hit by moving equipment

load top changing equipment which gives automatic voltage regulation underload in order to maintain satisfactory face voltage underground. The main transformer secondary winding is connected wye and has a 48-ohm, 5-kv, 50-amp continuous ground resistor connected in the neutral circuit. It is connected to earth by copper conductors in test holes through the seam of coal to be mined. Ground contact has been measured and found to be less than one ohm.

Each transformer is connected through its respective Magne-Blast main breaker to five individual load breakers. Ground fault tripping of main breaker is obtained by insulated neutral current transformer and a ground fault relay. Ground fault tripping of individual load breakers is obtained by the three-phase balanced flux "Donut Type" current transformer and a sensitive ground fault relay.

Bore Hole Cable. Figure No. 2 is the original underground power distribution system as supplied by bore hole No. 2. This system plus those supplied by bore holes Nos. 1 and 3 (not shown) are the ones for which the equipment was purchased for Thunderbird. Each bore hole cable is supplied power by a 3-phase, 4-wire, No. 4/0 stranded copper overhead transmission line. Each transmission line is protected by its own respective circuit breaker affording overload protection and selective ground fault tripping. Each circuit is protected against lightning with lightning arresters both at the bore hole and at the main substation, grounded independently of the 5-kv system ground.

Each bore hole cable is steel-armored 350 MCM aluminum, 8000-volt cable. This type of cable was purchased in order to afford better protection to the cable and to afford greater factors of safety against insulation failure within the cable in the bore hole. Each bore hole cable is terminated to a circuit breaker, either single or double breaker, depending on its location. At this breaker additional lightning protection is provided against lightning getting into the underground system.

Bore Hole No. 2 System. In order to simplify discussion and explanation of this power distribution system, only the system as supplied by bore hole No. 2 will be discussed.

The writer has tried to show the maximum permitted connected equipment to this bore hole distribution system while still maintaining proper voltage regulation. Normally, it is intended that part of this equipment will be connected to bore hole No. 3. First, it may be advisable to state that, for the original installation of the equipment at this mine, bore hole No. 2 and No. 3 are approximately 5000 ft, measuring along the transmission line, from the main substation. The location of bore hole No. 2 and No. 3 is in the approximate vicinity of the transfer of the coal from the section belt to the main belt. The No. 4/0 cable, 5000 volts, connected together in lengths of 800 ft, supply power along the section. All five-kv cables are connected together and to the breaker skids by multiple conductor 300-amp, 7.5-kv couplers. The 225-kva portable power center is connected by a 200 ft length of No. 4, 5-kva power cable to its individual breaker on the two-breaker skid. This power center supplies power for the 150-hp section belt motor and for power distribution along the main entry and section entry. Power distribution along the entry is mainly for tramming equipment under its own power or in case a roof fall necessitates a clean up.

Portable Power Centers. The distribution, two-breaker skid as shown supplies power to four 300-kva and two 225-kva portable power centers. Each 300-kva power center supplies power 3-phase, 480 volts, for one complete operating face unit. Each 225-kva power center supplies power to two 36-in. panel belts, power along the entry, lights and any additional equipment that might be required. In an emergency the 225-kva power center may replace the 300-kva unit. All power centers are equipped with a 15-kva, 3-phase, 208/120 volt secondary for lighting along the entry or at the face. Each power center is equipped with a 120-kvar capacitor for the 300-kva unit and 80 kvar for the 225-kva unit. Each power center is protected by its respective 5000-volt single breaker.

It may be worthy to note that each power center is connected to the single breaker skid by a 125 ft length of No. 4, 5000-volt cable. At the power center the cable is connected solid to the high voltage terminals. This short length of cable is moved with its respective power center and to do so, it is coiled upon the top of the power unit. All five-kv power distribution units are not permissible. They are installed on in-take air.

Six-Breaker Distribution Boxes. Type PCG, 400 MCM, 3-phase, 600-volt cable connects the first six-breaker permissible distribution boxes to the power center. To retain satisfactory voltage at the face unit equipment motor terminals, a maximum of three six-breaker boxes may be connected in series. Two insulated control wires in the PCG cable complete the holding circuit of the LM breaker on the power center. The short circuiting cap is required to complete this circuit on the last six-circuit breaker box used. The ground conductor in the PCG cable is connected from the frame of the power center to the frame of the six-breaker box. The six-breaker box provides individual breaker overload and instantaneous ground fault protection for each piece of equipment except the shuttle cars. A two-breaker permissible distribution box provides power to the shuttle cars. It is connected as shown to the K-breaker in the six-breaker box by a No. 2, 3-

conductor, type G, 600-volt mine power cable.

It is theoretically impossible to energize any of the five-kv power centers with an open in the ground continuity check circuit, either an open in the ground conductor frame to frame or in the insulated control wire within the cable. Therefore, low level ground potential is maintained throughout the entire five-kv distribution system. Face region equipment is connected to the power center frame by ground conductors in their respective cables and the ground conductors in the low voltage distribution type PCG cable.

Intrinsically safe circuits for the low voltage distribution system prohibits closing load breaker before properly attaching cable coupler. Consequently, disconnecting the cable coupler trips respective load breaker before power leads are open. Plugs are therefore attached and disconnected while the circuit is deenergized.

Panels 2, 3, and 4 are connected to their respective load centers in a duplicate manner as panel 1.

Two-Breaker Skid. Figure No. 3 is an actual photograph of an oblique view of a two-breaker skid used at either bore hole 2 or 3. The underground two-breaker switchhouse, portable skid mounted, is arranged for one incoming cable and two outgoing cables connected to the multiple coupler sockets. Each outgoing circuit is protected by its own oil circuit breaker rated 600 amp, 5 kv, manually operated, and equipped with auxiliary switch and capacitor trip device. Indicating pilot lights—red, for "power on" mounted immediately above the outgoing coupler sockets, are operated from the auxiliary switch on the breaker.

The gang operated disconnect switch rated 400 amp, 5 kv, visible through the wired glass window, is mechanically interlocked with both circuit breakers. Ammeters and voltmeter with suitable scales are flush mounted on the instrument panel. The weight of this drip proof breaker skid is approximately 5000 lb. Its over-all dimensions are 128 in. long, 48 in. wide, and 43 in. maximum height.

300-KVA Power Center. Figure No. 4 is a view of one of the 300 kva mine power centers with the breaker compartment doors open. The transformer is rated 300 kva, 3-phase, class H silicone insulation with porcelain no-load tap changer for four 2½ percent taps, two above and two below normal. The transformer section of this mine power center is nitrogen sealed. The low voltage section is totally enclosed with gasketed doors. The two main low voltage main breakers are rated for full transformer capacity. Each is wired through a balanced flux window type, 3-phase, ground current detecting transformer and ground current relay to provide time delay for coordination of main breaker with remote low voltage distribution center. Each main breaker is connected to its respective low voltage cable socket for use with the 400 MCM cable.

Two additional feeder breakers are supplied, one to supply power to the 15-kva lighting transformer primarily, and the other to supply power to the 120-kvar capacitor bank. Each breaker is connected through a balanced flux window type current transformer and instantaneous ground relay.

It might be well to mention both the power centers and the breaker skids are reinforced to withstand impact damage from beyond normal roof fall.

Figure No. 5 is an actual photograph of one of the six-breaker permissible distribution boxes. This distribution box was described along with the description of the mine power distribution system. You will note piping has been added to this distribution box to afford protection from falling objects and damage to the cable sockets from being hit by moving equipment.

Considerable engineering has gone into the design of equipment and installation used throughout the power distribution system as outlined above. Thunderbird mine has not been neglected for want of equipment to make a safe and flexible distribution system that is as safe from shock hazard as is humanly practical.

Methods of

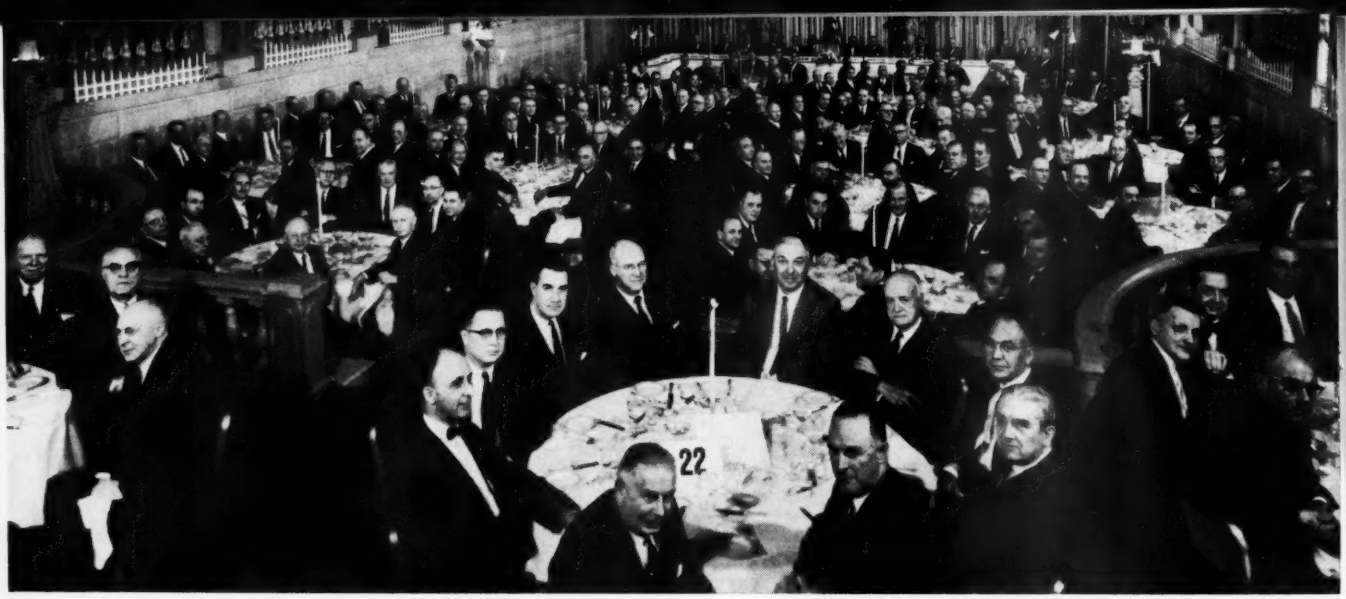
Reducing Operating Costs

(*Continued from page 47*)

vision. Yet, it has been proven that such plans are rarely effective unless there already is a satisfactory employer-employe relationship. There are many things that incentives will not do. In fact, it is even possible that their installation will create new problems without solving any that already exist. There are successful supervisory incentive plans of course, but none should be considered as a panacea. If there is to be a program of effective cost reduction, there is no substitute for good management—good supervision.

The industrial engineer with his training and applied means for obtaining helpful operational data is often the most logical person to help the foremen develop the necessary supervisory skills to assure such savings. Yet, if he is to be effective in this relationship, the industrial engineer must have an ample opportunity to win the confidence of first-line supervisors, to work with them and to share their problems with them. Obviously, this relationship would be simplified if the industrial engineer were employed in a line operating capacity. This arrangement, however, is not always possible. On the other hand, he is too often used strictly in an isolated staff capacity with the sole function of establishing labor and material standards. Such standard data is essential to many aspects of management; but at the level of the first-line supervisor, its first importance is that foremen understand its purpose, accept it and be both capable and willing to use it to effect savings. A foreman is not as much interested in the measurement of his over-all operations against standards as he is in that assistance which he feels will help him eliminate his production or cost bottleneck. Such bottlenecks, in the opinion of many foremen, also do not necessarily coincide with that indicated by strict standard data. Therefore, if the industrial engineer is to make the maximum contribution to supervisory success in reducing costs, he must be more than the writer of the game rules, he must be on the team. It is there that he can best gain that certain experience and so combine his skills with other supervision that the factors of industry—men, machines, materials and methods—can be brought together for better and more profitable production.

Costs can be reduced, employe productivity and equipment productivity invariably can be improved. Certainly, these must occur if the industry or any individual company is to continue profitable operation and be ever able to meet new competitive challenges. We cannot discount any of the modern cost controls available to management. But at the same time, let us never overlook or even regard lightly the many personnel factors, the attitudes, the relationships upon which all real and lasting business success depends.



American Mining Congress Annual Business Meeting

THE annual membership meeting of the American Mining Congress was held in New York City on Monday, November 30. Industry leaders in coal, metal mining, industrial minerals production and equipment manufacturing gathered for the dinner meeting at which the business affairs of the 61-year-old organization were transacted.

Raymond E. Salvati, AMC president and president of Island Creek Coal Co., presided over the dinner program as well as the directors' meeting that followed, and introduced other AMC officials to present their regular reports.

Treasurer's Report

Andrew Fletcher reported on the financial status of the Mining Congress, showing that for another year receipts have kept slightly ahead of expenditures. He alluded to the forthcoming "stretch-out" in the Exposition schedule from a two-year to a three-year cycle, beginning 1961, which means a Coal Show in one year, a Mining Show the next year, and no show in the third year, but with the regular "paper conventions" in the off-years. To compensate for the loss in revenue, he said, the manufacturers have volunteered an increase in space rates and dues—and their continued support is warmly appreciated.

Julian Conover, executive vice president, was prepared to make a detailed report on the work of the Mining Congress in 1959, but with the concurrence of President Salvati he dedicated this time to the guest speaker and gave the following thumbnail sketch of how the American Mining Congress stands: "1. We're in the black; 2. We're hoping to stay that way; 3. We're not asking for any big hike in dues; 4. We've had wonderful cooperation from all branches of the industry—coal, metals, industrial minerals and equipment manufacturers; 5. We've done our damdest to seek sound policies for the benefit of the entire industry; 6. Our heads are bloody but still unbowed; 7. We'll pay tonight's bill! Thank you very much Mr. Chairman and Gentlemen."

The Price of America

Representative Jackson E. Betts of Ohio, member of the House Ways and Means Committee, was the guest speaker of the evening, filling in for Representative Richard M. Simpson, who had been ordered by his doctor to cancel all speaking engagements and to take a much needed rest before resuming his arduous schedule.

Betts urged his listeners to take a more direct interest in politics and in guiding public opinion to maintain the ideals of freedom. Too many business men, he said, have confined their political activity to voting on election day, thereby exposing our free enterprise system to the undermining encroachment of Federal bureaucracy. He observed that "Fed-

eral, State and local tax collections take one-third of our net national product. Thus, we are one-third along the route of socialization."

Betts emphasized the need for sound fiscal policies to avoid deficit financing. If we can hold our spending at 1959 levels over the next five years, he said, economic growth can provide the budgetary surplus that will enable essential and sound tax reduction. If tax reductions are not now possible, then we must energetically preserve existing tax incentives for savings and investment, because our economic growth has been made possible by invested savings. Our tax laws, he said, must provide adequate depreciation, realistic depletion, and proper dividend credit if full economic and industrial potential is to be realized.

In the field of tariffs, Betts said that the basic purpose of our trade agreements program—enlargement of foreign markets to American production—has been lost sight of over the years, and that "trade policy must be predicated on economics with the fundamental objective of maintaining a strong domestic economy."

The responsibility of business in guiding public opinion along the right channel is, Betts declared, the price demanded by patriotism—"the price of America."

Directors and Officers Elected

Eight industry leaders were elected to serve as directors of the American Mining Congress, each for a three-year term. The nominating committee, under the chairmanship of Frank R. Milliken, presented the names of: D. E. Davidson, vice president, Link Belt Co.; Andrew Fletcher, president, St. Joseph Lead Co.; Herbert C. Jackson, managing partner, Pickands Mather & Co.; Frank Nugent, president, Freeman Coal Mining Co.; Robert G. Page, president, Phelps Dodge Corp.; L. J. Randall, president, Hecla Mining Co.; Raymond E. Salvati, president, Island Creek Coal Co., Huntington, W. Va.; and Ellery Sedgwick, Jr., president Medusa Portland Cement Co. All of the men nominated were elected by unanimous ballot.

A silent tribute was paid to the memory of Louis S. Cates, director and member of the executive committee for the past twenty years and president of the American Mining Congress in 1925 (died October 29, 1959); and of John D. Bradley, chairman of Western Division in 1958, and his wife Jane (died November 26, 1959).

The Board of Directors of the American Mining Congress met immediately after the annual business meeting and elected the following officers for the year 1960: President–Raymond E. Salvati; Vice Presidents–Andrew Fletcher, Herbert C. Jackson and Clyde E. Weed; Executive Vice President and Secretary–Julian D. Conover; Executive Committee–Raymond E. Salvati, Herbert C. Jackson and L. J. Randall.

Other action by the board included: (a) the approval of nominations for membership on the Advisory Council of the Coal Division and on the various standing committees of AMC; (b) the formation of a Copper Producers Committee to investigate the feasibility of undertaking an exchange of visits between the United States and the Soviet Union by delegations from the copper mining and refining industry; (c) approval of the Declaration of Policy adopted at the AMC Convention at Denver as an expression of policy of the American Mining Congress, and (d) adoption of a resolution commending the Governors of the Western States for their interest in and support of the mining industry.

Special Committee Meetings

AMC Tax Committee Chairman Lincoln Arnold president over an all-day tax conference on November 30. More than a hundred tax men attended and discussed a wide variety of tax matters of current interest to the mining industry—particularly including administrative handling of depletion "cut off point" problems and possible legislative activity in connection with the Ways and Means Committee hearings on "broadening the tax base." Several speakers, including Congressman Betts, addressed the tax group.

The Land and Water Use Committees of the American Mining Congress and the National Coal Association met the following day under the chairmanship of R. L. Ireland, chairman of the executive committee, Consolidation Coal Co. The group discussed bills now pending in Congress which would require the Secretary of the Interior to make a comprehensive survey of strip mines throughout the country. The group was of the opinion that such a survey would not be a proper function of the Federal Government and that it should be handled by local and State agencies.

After considering the growing interest in air pollution among the extractive industries, a motion was unanimously adopted to add this subject to the committee's area of operations. Also discussed at the meeting were the field trips taken, and to be taken, by committee members to mining operations in various districts of the country and the need for even greater interchange within the committee of information pertaining to land and water use and air pollution.

By GORDON T. BETHUNE
Assistant Comptroller
Oliver Iron Mining Division
U. S. Steel Corp.

COST ACCOUNTING AS A MANAGEMENT AID IN IRON ORE MINING

Scientific planning and intelligent action by management can result in cost control and cost reductions in the face of two major problems confronting the industry: competition and the increasing complexity of mining and processing activities

THE purpose of this article is to discuss some of the very serious problems facing management today, and to explore some of the aids available to management for solution of these problem areas.

Two of the biggest problems facing the iron ore industry are: (1) competition—from within the industry itself and from substitute materials—and (2) the increasing complexity of our mining and processing activities—complexities which have resulted from natural depletion of large low-cost high-grade deposits, and from our own efforts to compete successfully through greater utilization of beneficiating facilities so necessary for quality improvement.

It is the writer's opinion that cost control and cost reduction are one of the answers to the problems. Further, these answers must come through intelligent managerial control based on a knowledge of all the factors that make possible scientific planning and intelligent action.

There is nothing mysterious about cost control—it is based upon plain ordinary common sense. When a man works, he does so because he hopes to make or get something he needs. This is likewise true of any business. The ultimate aim of any business is profit. Concerns cannot continue to operate unless they are making profit.

There is, of course, no guaranteed rate of profit in competitive industry. Profit, strictly speaking, is that part of revenues which is left over after all costs are met. Obvious is the fact that low cost operation is important to the individual company because its financial success, its future development and expansion, and indeed its very survival, are dependent upon it. It is easy to see how important cost control and cost reduction are in the iron ore industry today.

Standard Costs—Measure of Planning and Performance

Effective cost accounting is one of the best tools to effectuate managerial control, and a budgeted or standard cost system provides the basis for that effectiveness. Standard costs, very simply, are predetermined allowances for various cost elements and operating activities. They establish measurements of the effectiveness with which operations were planned and performed.

The objective of a standard cost system should be to develop and present accurate and complete facts in order to attain the most effective control over, and results from, all company activities at each level of management.

How many times have we heard—"Standard Costs—sure they're fine for cost control—in a factory, where everything is pretty routine, under one roof and run on an assembly-line basis. They won't work in mining however—too many variables. You just can't put a standard on Nature." Familiar words to most of us.

In analyzing the applicability of standards to the Oliver Iron Mining division mining operation, it was decided that the problem, if any, revolved around: (1) predictability—of the various mining conditions, and their rate of encounter in a mining cycle; (2) the seasonal or cyclical nature of mining which, at first glance, would seem to generate nothing but variances, due to the lack of "typical or standard" operations, except on a long-term basis; (3) the influence of weather.

It was concluded that a standard cost system with built-in flexibility to cover the unique characteristics of mining would provide the means of positive, effective control. The system should include recognition in standards and in performance determinations of changing geological and geographical conditions, such as, haul and lift, chemical and physical characteristics of materials encountered (which affect loading and haulage speeds, and ore beneficiating processes and results). It was reasoned that the effect of weather would tend to level out and not be too significant.

We believe that the system developed and installed at Oliver gives

a common sense, logical and scientific approach to management control. The system enables us to:

(1) Measure and compare the performance of mines, plants, shops, offices.
(2) Plan expenditures, by providing the necessary cost and financial data for a factual evaluation of facility additions and replacements.
(3) Fix responsibility so each department head or operator will know and be able to explain the costs incurred under his jurisdiction.
(4) Highlight variances or exceptions so that the operator can take immediate action under the principle of "Management by Exception."

There are several steps of standards development and control features of the system that deserve scrutiny.

At the outset, it should be pointed out that although definite responsibility can be assigned for completion of the several development steps, the best development and application requires complete cooperation and coordination of all phases of operations and of all members of management. It is truly a team effort.

Establishment of Responsibility

In establishing a standard cost system, it is first desirable to define areas of responsibility within the organization for which separate costs should be developed. Each area may consist of one or more operations or activities, but for which one person only is directly responsible. There should be no part-time or divided responsibility. To effectively control costs, it is essential that individual supervisors be given clear-cut and clearly defined limits of authority and responsibility.

A responsibility specification should thus be developed which clearly outlines and defines the areas and boundaries, and such other factors as equipment, materials, expenses, services and personnel requirements of the cost center. Cost improvements in the form of organization changes and realignment of responsibility are very likely to be effected in the course of this development step.

Next, there should be determined a set of conditions which will be designated as standard practice. This standard operating plan should present a balanced, practical, low-cost method required to produce predetermined volumes of product and services.

The standard operating plan thus provides a common basis, objective, and benchmark for all activities of the company. It enables all departments of the organization to look in the same direction, and to travel the same road together. Through the standard operating plan all can work together toward the common objective of developing the yardsticks against which one can measure management performance with respect to costs, facility planning and operating practices.

Describe Operating Practices

Standard costs are founded on basic standards. Basic standards state *how much* of *what* equipment, material and manpower is required:

(a) to perform each necessary operation, and
(b) to produce a unit of product or service.

The basic standards reflect specific operating conditions and practices, and

(a) identify each product,
(b) specify the equipment, material, and personnel to be used to produce it, and
(c) tell how the product is to be made with them.

The formal descriptions define and detail significant factors with respect to available equipment, product to be produced, materials to be used, process requirements, operating sequence, methods and required crews.

Development of a standard cost system was previously mentioned as a logical, scientific approach to cost control. The various descriptions just reviewed are a good example of that approach—properly defining a job and establishing the best possible way of doing that job.

Basic Standards

A standard cost system is no better than the foundation of basic standards on which it rests. A basic standard is the physical amount of equipment, time, materials and man-hours required to perform a specific operation, on a given product, under specified conditions. The principal types of basic standards are:

(1) Production or time standards—indicate in terms of hours the time required to produce or process a unit of product through a particular operation.
(2) Material standards — indicate the weight of specific materials required to produce a ton of specific product.
(3) Labor and other cost standards—indicate the number of units of production expense, such as man-hours, transportation, stores, supplies, repair and maintenance, etc., required per unit of product produced or service rendered.

Production standards are established for shovels, locomotives, drills, and other equipment. These basic standards, when related to standards for geological and geographical conditions—such as height of bank, type of material, length of haul, etc.—provide a sound basis for performance measurement and cost control

Basic standards and standard relationships must be developed for all activities and functions—in mining, that would mean in mines, plants and shops. They would range from shovel speeds, to track-man hours, to weight recoveries in washing and agglomerating plants. Some are rather simple while others are quite complex.

The following three methods can be used in this development:

(1) Engineering—Job analysis and time and motion studies.

(2) Historical—Analysis of past performance.
(3) Estimate—Estimates by operators, engineers and other experienced personnel.

A most important factor in the development and maintenance of standards is the soundness of the level of standards.

Standards which are unrealistic—those which are too high or too low—are of little value for control purposes. They reduce the usefulness of product costs, since they can be misleading to management. Care must be constantly exercised by all concerned to assure that standards are set at the proper level and that new and improved methods and practices are promptly comprehended.

Dollarizing the Standards—Standard Product Cost

After the basic standards are developed, the next step is to convert them to a common measure—dollars. The dollar allowances so developed for each expense item of a cost center are added together to arrive at a normal budget. The summation of these budgets from the various applicable cost centers gives us standard product costs—for direct shipping ore, wash ore, sinter, coarse, fines, etc.

Discussion to this point has dealt with responsibilities, practice descriptions, basic and dollar standards, and the determination of standard product costs—all development steps. Next, consider the system at work. The standards will be applied to current activities and will be used to provide operating control data through responsibility budgets and variances.

One of the principal advantages of a standard cost system is that it readily provides a means of cost control on an exception basis. Cost control results from comparisons of "what costs should be" with "what costs are".

"What costs should be" for any given period of operations is developed by applying standards to the current period's activity. These standard costs are compared with "what costs are," which are the actual costs of the period, and the difference is variance.

It is important at this point to recall one of the fundamental principles of a standards system—"The system shall reflect operations as planned and as executed" and shall recognize budget adjustments to comprehend deviations beyond the control of management. This means that reflected in "what costs should be" are properly adjusted allowances for changed (primarily due to unpredictability) geological and geographical conditions as they affect such factors as haul and lift; washing plant yield; type of materials handled; waste materials encountered, etc.

Recognition of the influence of these and similar factors in the budget or "should have been costs" provides a good yardstick for the measurement of operator performance in a mining-type operation.

Variances and Corrective Action

Variances generated in a standard cost system serve to focus management's attention to those areas where corrective action must be taken to insure that operations will be carried out as planned. Variances provide the tools for "Management by Exception". They permit management to concentrate its efforts on improving those areas where significant unfavorable variances are being generated, and to bypass those areas which are operating as preplanned.

A formal variance analysis program which develops timely and regularly scheduled reports and analysis and guides for preplanning is one of the best ways to put the standard cost system to work for the supervisor. Through such a program, the supervisor can be made aware of and can study his cost performance and initiate corrective action. Without this awareness and corrective action, the standard cost system fails in the purpose for which it is designed.

From the foregoing, it must not be construed that a standard cost system is a cure-all and that it is a replacement for management. It is merely a management tool, but a tool which, through the coordinated efforts of operators, engineers, accountants and all other departments, can be effectively applied to mining activities.

Underground Shaft Sinking at Climax

(*Continued from page 44*)

An air and water bazooka is used to sweep the bottom prior to further drilling. After two rounds are blasted and mucked out, the third round is shot and enough muck removed to allow the placement of forms for a 20-ft section of concrete.

The concrete work cage (see fig. 3), carrying the necessary shaft steel and equipment with the shaft steel aligning jig hung under the cage, is lowered to the muck pile on the shaft bottom. The jig is removed and the work cage is hung in the shaft from the last set of permanent steel at the proper level to lower the forms. The jig is centered and leveled and the vertical steel is bolted to the jig and the ends of the steel beams in the previous concrete pour.

The circular steel form is divided into six vertical sections and each section is supported at the top by bolts imbedded in the concrete. The hoist cable is fastened to the top of a section of form, supporting bolts and wedges are removed and the section is lowered 20 ft. The forms are slipped in four to six hours.

20-Ft Section of Concrete Lining Placed in 8 Hr

Concrete is mixed on the Storke level station and dropped through a six-in. slick line to a hopper on the top deck of the work cage. It is distributed behind the forms by a swivel "elephant trunk" drawing off the bottom of the hopper.

Concrete slump is maintained at four or five in. About eight hours are required to place a 20-ft section of concrete lining and this operation takes six men; two on the bottom, two mixing concrete and two bringing dry aggregate and cement from the outside batch plant. Installation of manway, pipelines and crosshead guides is usually done while the work cage is in the shaft.

Water has not been a major problem to date, but some grouting has been done in a fault zone 265 ft below the collar which familiarized the crews with the procedure. Portable grouting equipment can be brought to the collar of the shaft on short notice.

The total depth of the shaft will be 767 ft. In this distance there will be four 14 ft wide by 16 ft high stations entering from both sides of the shaft, two skip loading chutes and pockets and a spill chute station under the skip compartments at the bottom. The longest section of straight shaft sinking will be 200 ft. Average cost per foot for the first 300 ft of shaft was $550. This includes excavation, concrete lining, manway and service facilities.

Needless to say, many problems were encountered during the first 300 ft of sinking with an inexperienced crew. The crew has now gained experience and can be expected to proceed with increasing efficiency.

FUTURE TRENDS in STRIP MINE HAULAGE*

Strippers want to haul larger loads farther, faster and cheaper

By THERON G. GEROW
Consulting Engineer
Minneapolis, Minn.

COAL mine operators want to haul bigger loads farther, faster and at a lower cost. Manufacturers want to supply such units if the market will support the necessary development at a profit and if technically they can develop suitable and satisfactory motors, transmissions, axles and tires for the bigger loads.

One manufacturer says: ". . . bigger and faster hauling equipment for the coal fields is not only required but actually exists."

An operator states: "The trend for more power and speed that has been so great in the automobile and aircraft industry seems to be coming to the heavy equipment industry."

Trucks in 50-Ton Range Are Today's Standard

Coal haulers up to 50-ton capacities can now be accepted as standard units with satisfactory and proven equipment being offered. Several manufacturers have fleets of this size in service. Seventy, 80, and up to 100-ton units are being tested.

Units of these larger sizes were contemplated many years ago and several pilot models built and put in service. Even the multiple engine and double-end control were offered a long while back. However, technical development and progress has lagged so that at the present time trucks in the 50-ton range are the maximum standard.

With the advances in large capacity stripping units, high capacity cleaning plants and large tonnage mines made necessary in order to produce low cost power plant fuel, the demand has grown progressively for the large capacity coal hauler. It has caused the development of the 50-ton unit to its present level of efficiency.

One well-known operator goes on record as follows: "(The) trend is leading to fewer (and) larger mines . . . and the improvement of high horsepower engines and torque converters is permitting the use of larger haulage units," and adds, "the increase in wage scales has been another influence in the trend to larger and more powerful haulage units."

The choice in the size of the coal hauler to be used is, of course, dependent on many factors and the 100-ton hauler, when developed, cannot be universally used, any more than can the 60, 70 or 90-cu yd shovels. However, the necessity to produce low cost coal in volume is forcing the entire mining trend into high capacity machinery of all kinds. Present standard coal hauler units in the 25, 40 and 50-ton class will still provide the economical and practical choice for many operations.

It goes almost without saying that the high capacity trucks are, and will be, purchased as fleets rather than replacement units.

One operator puts it this way: ". . . we have ordered a few additional trucks for our mines but have ordered units standard to the haulage fleet purchased originally because of spare parts."

The big trucks require big loading shovels to avoid loss in cycle time at the loading pit. Travel time over the haulage roads will be different than for the smaller units. The haulage cycle must be kept uniform to avoid congestion and provide smooth operation. Roads must be better. The big boys will require better shop facilities and an entirely new parts inventory. Hence, they will not be of much interest as minor additions to existing smaller capacity fleets. Their use will result from a predetermined and well-engineered plan.

Operators Want Higher Capacity Units

The major strip mine operators without exception report that they want higher capacity units. Eighty to 100-ton trucks are the popular demand. Designs contemplated range from the present bottom-dump semi-trailer to the double-end, double-powered and double-controlled shuttle unit. Hauls are lengthening and more speed is being asked. The operators are apparently willing to provide the necessary good haulage roads and improved pit layouts which they will require.

Some typical comments read as follows: "We are of the opinion that we could reduce our present haulage costs with this type of unit" (this refers to a 100-ton unit presently under investigation) "by approximately 25 percent."

"With larger, proven, component parts now available, a 100-yd unit will be every bit as practical as the smaller units now operating."

"We feel a unit of this type" (a 120 to 130-ton unit that is being developed) "will be much cheaper to purchase, maintain, and operate over

*A report on the views and opinions of manufacturers and coal mine operators as expressed in their replies to an inquiry sent out in contemplation of preparing this article. Both the manufacturers and operators were most cooperative in their replies. Conclusions drawn are based on a tabulation of about 15 comprehensive answering letters.

Original cost, plus operating cost, plus performance are the governing factors in selecting truck size

long distances than either belt or rail installation."

"I believe the industry is ready for a good 100-yd unit, but am not certain that the manufacturers as yet can produce such a unit having sufficient horsepower in the engines and adequate transmission and adequate axle to insure trouble-free service from such units."

Major Problem Is Horsepower, Not Size of Unit

Again without exception the operators want more power. Four hundred to 450 lb of gross load per horsepower appears to be the choice. Naturally aspirated diesel engines, derated in horsepower, are favored for coal mine service. For the ultimate in payload to gross-load ratios, however, the turbo-charged engines are being considered. With present equipment the operators feel that the engine derated in horsepower gives better service with considerably less maintenance.

On the subject of power one operator's comment sums up the opinion of several: "I feel, and our experience has proven, that we have always been underpowered for the amount of coal and weight we have tried to transport."

And a manufacturer says: "The major problem now is not the size of the unit . . . (The) problem is horsepower. Until further engine development is done, the equipment manufacturer is fast approaching the maximum . . ."

As to supercharging, an operator states: "Early in 1958 . . . the engines being offered were turbocharged, which in our opinion, tends to overwork an engine in order to provide the necessary or indicated horsepower."

Opinions Divided on Transmissions

The operators are divided as to their opinions on transmissions, probably influenced by present experience and equipment. Most seem to favor the straight transmission, yet recognize the advantage of a properly designed torque converter. It would appear that the torque converter will necessarily become an integral part of the higher horsepower and higher tonnage units. Their design, however, must keep pace with the increase in horsepower demand.

Examples of opinions on transmissions range as follows: One of the largest users of trucks says: ". . . it is our opinion that the straight mechanical drive is the more desirable. . . . However, as the size of trucks increases and design problems of transmissions, and clutches become greater, the torque converter begins to show more promise."

Another says: "Our own cost records show that the lower maintenance cost more than offsets the extra fuel cost for a torque converter unit."

A recent purchaser of a fleet states: "We feel the use of automatic transmission is a step in the right direction in that shock loads to gear trains are greatly minimized as opposed to manual clutching and shifting."

Yet another says: "We have made several tests on units with the torque converter but have not felt their use was worthwhile. . . ."

Large, Single Tire Favored

Tire manufacturers take note. The operators all favor the large size single tire for many reasons and deplore the fact that most haulage trucks are undertired and singles only available on certain models. Satisfactory tires with good flotation, load carrying ability and shock absorbing qualities all combined in a low maintenance unit will be a "must" in the development of high capacity haulage trucks. Tire builders must face and solve the problem.

Operators comments are typically as follows: "We . . . feel very strongly that if it were possible to carry heavier loads on single tires, we would prefer this type of unit mainly because of their mobility and floatability in soft going. They are particularly advantageous in dragline pits where haulage is on the fire clay."

"In the case of short hauls, steep grades and rough operating conditions we lean toward the single tire unit of 40-ton over the 50-ton units with dual tires."

We prefer single tires because of "less wear on turns because one tire in a set of duals tends to skid" and "more traction on one surface."

"Our experience is that though one single tire costs more than two duals, our cost per mile on the tire is cheaper with the single."

"Our latest purchase will be dual tires. The tire companies evidently are too little and too late with a

single tire for the heavier loads."

The three-axle, semitrailer, bottom-dump haulage truck is the most popular design. However, it is again recognized that the tandem axle may be necessary for proper traction as more horsepower goes into the haulers, either more axles or a new design. The shuttle unit with a double end, double power and double-end control is receiving a lot of consideration. Such a unit was proposed a long time ago—but to the writer's knowledge was never built, at least not in production.

Diesel-Electric Truck Considered

The diesel electric with independent motors at the wheels is again being considered. "Again" is used advisedly for the electric drive has been tried before. It would seem that from many angles this would be an ideal drive if the design can be developed rugged enough and completely impervious to weather and road conditions.

One operator goes so far as to say: "The experiment that I would like to see the truck manufacturers undertake is (to) make the truck a diesel-electric unit, with diesel engine and generator up front, with high torque electric motors with planetary reduction gears in the hub of what we now call the drive wheels, and the same thing again in the hub of the semitrailer wheels. This would give twice the traction, the effect of a 'no slip' differential, and the effect of a torque converter. Also, by keeping the engine at a constant rpm you would get much better life and service out of it. I would be willing to pay a premium for a truck of this nature."

Improved Auxiliary Equipment Needed

In addition to the foregoing basic considerations, the operators agree that many improvements are needed in auxiliary equipment. Nearly all asked for improved cabs, better turning radius, improved door operation, better steering, brakes, etc. To improve the payload ratio, they are asking for the new steel in bodies, such as T-1, or further development in the use of aluminum.

Two sample comments follow: "There is no doubt, however, in our experience that all of the latest equipment should be added to the units, such as good and better seats, good visibility, power steering, etc. It only takes a small amount of money to have good heaters, good seats, and things of this kind which pay dividends for each and every truck and operator."

"Proper cab design is important. Current design is too wide, causing brackets and frame rails to break. Cab should be just large enough for driver and one passenger, thus giving more jack-knife room and better visibility."

Truck Makers Are Aware of Demand

Manufacturers, at least the progressive ones, know what the operators want. They know that they want bigger and better coal haulers to match in with progress and improvement in other mining equipment. They know the operator must have the lowest operating cost possible and that haulage is an important link in the strip mining chain. Yet the manufacturer has problems, too.

"Easier said than done," they quote, and to continue the quote, operators' ". . . ideas of what is wanted vary . . ." They plead the cause of cooperation between manufacturers and operators in view of the expense of developing these larger units.

It has taken over 20 years to develop the coal hauler to a satisfactory 50-ton standard. Progressive steps were the 20-ton, the 25-ton, next the 40-ton and currently the 50-ton range. The next hump to the 80 to 100-ton class means doubling present capacities and will require an extensive development program. Will the market economically justify the cost of such a program with provision for profit, and will the larger units offer savings enough to the operator to justify the capital investment?

From an engineering point of view the large coal hauler program will involve the development of satisfactory engines in the 600-hp range for 75-ton coal haulers and 800 hp for the 100-ton units. Transmission and drive units as well as axles must be developed. The tire manufacturers must be included to design and build adequate tires to carry the loads. Entirely new body and chassis designs will be needed. In fact, reaching beyond the 50-ton class will produce an all-new truck. Present specifications as to gross weight per horsepower and tare weight to payload will undoubtedly govern, but present designs have just about reached their limits and cannot be beefed up materially.

Will Larger Trucks Be Economical?

From the economist viewpoint, original cost plus operating cost plus performance are the governing factors in size selection. Present estimates as to the cost of the larger units are very much in line with the smaller units as to capital investment per ton of capacity. Operating cost estimates, however, rise rapidly with increase in the size of the unit. Flexibility, maneuverability and performance are all sacrificed as the size increases.

A rather extensive study, from the economist's viewpoint, has been made on size selection and ultimate cost per ton. Boiled down, it appears that the smaller units to 25-ton capacity are the most suitable for very short hauls and unfavorable pit conditions. The 40 and 50-ton units seems the most versatile and generally applicable to medium length hauls, say three to four miles under favorable haulage conditions. The 75-ton units will probably begin to show saving on the longer hauls exceeding three miles, and the large 100-ton trucks will take over at distances exceeding eight or nine miles.

Trend Is Definitely Toward Larger Coal Haulers

Summing up the operators' opinions and manufacturers' views, the trend is definitely toward the development of larger units to meet the modern mining requirements of large tonnages, longer hauls and lower costs. Manufacturers are already on the way with test and experimental units.

The ideal larger unit will probably be diesel-powered with a ratio of 400 to 450 lb of gross load per horsepower. The engine will probably be derated in horsepower for longer life and lower maintenance on the longer hauls. The transmission will be a locked-up torque converter coupled with about a four-speed gearing with auxiliary braking. Tires should be singles if at all possible. Bodies and frames will make use of the lightweight materials to increase the payload ratio. The design will be the conventional semitrailer with tandem drive axles or, if the diesel electric develops, three-axle design with independent drive at four wheels. For the very big loads the double-end shuttle units will probably be used.

The trend is definitely towards larger coal haulers. The operators want them, the manufacturers will supply them. Development now under way will eventually establish haulage trucks in the 75 and 100-ton class as standard as the 50-ton unit is today.

Will these be the ultimate? The writer doubts it, for he has already heard whispers of units to 200 tons.

Any way you look at it...

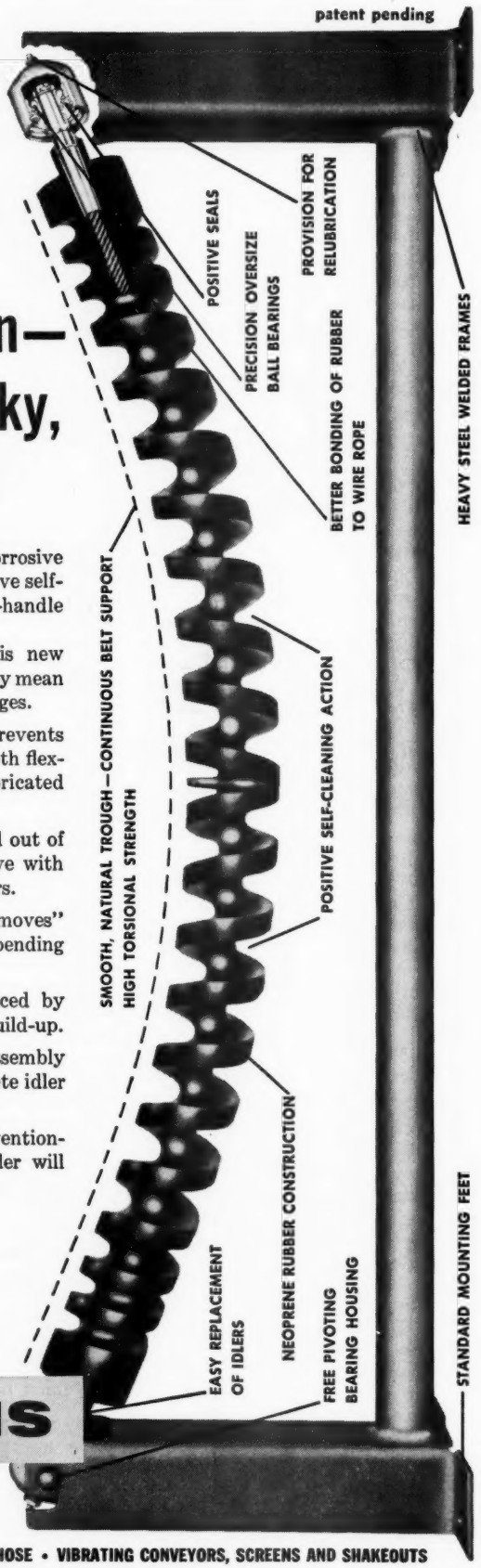
New Rubber Spiral Idler Defies Corrosion, Abrasion—Prevents Build-up of Sticky, Hard-to-Handle Materials

Here's the conveyor idler built to last longest in punishing corrosive atmosphere or extreme abrasive service! What's more, its exclusive self-cleaning rubber spiral prevents build-up of sticky, hard-to-handle materials!

The numerous design and construction advantages of this new Hewitt-Robins idler are shown in the illustration. Here's what they mean to you in terms of cost-cutting, time-saving, operating advantages.

- **LONG LIFE.** Neoprene spiral, completely covering wire rope, prevents attack in corrosive atmosphere. Uninterrupted spiral gives smooth flexing, maximum strength. Precision sealed bearings can be relubricated for still longer life.
- **SELF CLEANING.** As the spiral turns, it "works" any material out of the grooves as they change shape. This action is most effective with sticky materials which tend to build up on common types of idlers.
- **CONTINUOUS BELT SUPPORT.** The new rubber spiral design "moves" along the entire width of the belt; therefore, pinching and sharp bending of the belt are eliminated.
- **SELF TRAINING.** Belt training problems are greatly reduced by readily conforming rubber spiral, and by elimination of material build-up.
- **EASY REPLACEMENT.** The spiral, wire rope, and bearing assembly simply lifts out of its brackets—no tools are needed. The complete idler fits standard conveyor stringers.
- **TRUE OPERATING ECONOMY.** Under conditions where conventional idlers fail prematurely, the Hewitt-Robins rubber spiral idler will pay for itself many times over.

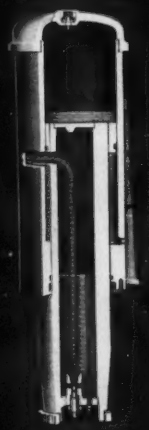
Deliveries of this revolutionary new idler are now being made in 18, 24, 30, and 36 inch belt sizes. For further information check your H-R distributor, or write Hewitt-Robins, Stamford, Connecticut. Ask for Bulletin 1-15.



HEWITT-ROBINS

THE NAME THAT MEANS EVERYTHING
IN BULK MATERIALS HANDLING SYSTEMS...

CONVEYOR BELTING AND IDLERS • POWER TRANSMISSION DRIVES • INDUSTRIAL HOSE • VIBRATING CONVEYORS, SCREENS AND SHAKEOUTS



HYDRAIR*

POWER-TRANSFER
DIFFERENTIAL

How these exclusive advantages help you cut hauling costs...

DEEP V-BODY

LW Haulpak®

These 3 cost-cutting advantages..

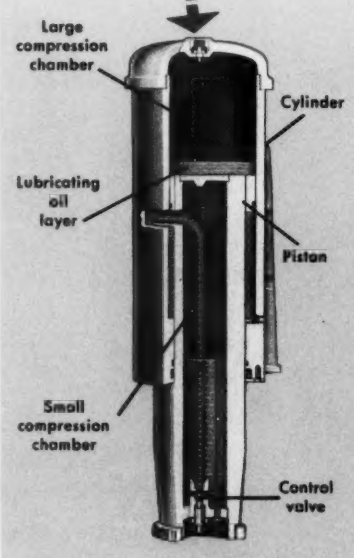
LW HAULPAK
Available in 3 sizes
22, 27 and 32 tons
290, 335 and 375 hp

1 HYDRAIR smooths rough haul roads

On LW Haulpak, you get a sturdy, simple air-hydraulic suspension system that eliminates the costly, time-wasting maintenance and repair of springs. Four Hydrair units cushion against loading and travel shock . . . compensate *automatically* for off-center loading and keep the load riding level over humps and holes.

Other Hydrair benefits:

Located high out of dust, dirt, and moisture, Hydrair cylinders permit higher ground clearance (23″) and sharper turning (Haulpak makes 180° turn in area only 44′6″ wide). The elimination of springs and conventional front axle also reduces non-profitable dead weight.



How this exclusive suspension system works

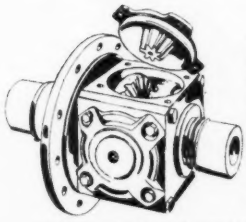
Basically, Hydrair operates like this: The upper compression chamber above the piston supports the load on a cushion of nitrogen gas and the lower compression chamber acts as a rebound chamber to snub the return or downward movement of the piston. The maximum stroke of the piston is 14 inches in the two front suspension units and as much as 7 to 9 inches in the two rear Hydrair units.

Conventional leaf springs have an "action space" of less than 4 inches, so it is easy to judge the tremendous improvement Hydrair represents as far as tire and vehicle life and operator comfort are concerned. Hydrair absorbs and cushions virtually all loading and travel shock, keeping this brutal punishment away from the tires, structure, and operator. Hydrair relieves the pounding on the road surface that creates "washboards".

s.....yours only in Haulpak

2 POWER-TRANSFER DIFFERENTIAL pulls load through soft footing

This same exclusive LW differential has boosted production and cut costs for thousands of LW Tournapull® owners for more than 14 years . . . and now, *for the first time*, it is available on a truck. The power-transfer differential *automatically* puts power on the wheel with best traction, so you can haul through soft, slippery spots that bog down conventional haulers. The differential action also reduces wheelspin and tire wear.



The LW Haulpak differential works *automatically* at *all* times, is as simple in construction and as trouble-free as an ordinary differential. When one wheel tends to spin, idler pinions are automatically forced outward against friction surfaces. This slows the slipping wheel, and transfers up to 4 times its tractive effort to wheel on firmer footing. Neither wheel will spin independently until the 4-to-1 ratio is exceeded.

HAULPAK saves you money many other ways:

LESS MAINTENANCE (entire lube-check, needed only at 500-hr intervals, consists of just 3 easy-to-reach grease fittings). *POWER-MISER FAN* (cools with 20 to 25 less hp drain). *FOUR SEPARATE BRAKING SYSTEMS* (for fast stops with complete safety). *POSITIVE POWER STEER* (for faster turning, easier handling). *SIMPLE SIX-GEAR FINAL DRIVE* (compared to 12 or more usually standard). *BIG, ROOMY CAB.*

3 DEEP V-BODY gives you bonus tonnage within short wheelbase

Haulpak's exclusive deep V-body allows you to haul extra tons of material within a short wheelbase. Loaded material quickly fills all corners for big, low-void payloads. Deep "V" also provides a low center of gravity . . . gives Haulpak better stability on turns for high-speed hauling no matter how rugged the road.

In addition, the Haulpak V-body is exceptionally strong. It is constructed of high-tensile-strength steel . . . nearly 3 times stronger than steel commonly used in trucks, yet it weighs ⅓ less. Result: *You haul up to 30% more payload than Haulpak's weight.*

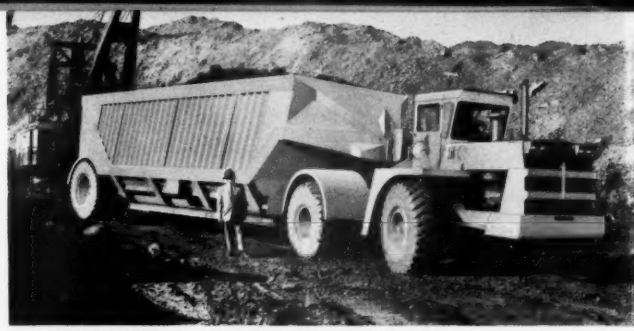
Bonus yardage in every Haulpak load rides in the exclusive V-shaped body. Low loading height (10'1") and large top opening (14'5" x 11") makes it easy for shovel operators to load Haulpak fast, without spillage. Heavy rubber pads provide 100% cushioning of the body against loading and travel shock.

HAULPAK LW 80...

offers new low in hauling costs,

80 tons, 100 yd capacity . . . speeds to 40 mph

Proved in strip mine operations, the 450-hp LW 80 hauls materials at lowest-cost-per-ton. Constructed of light, super-strong steels, Haulpak hauls more than 2 times its weight in payload! It is easier to handle and maneuver than 50-ton units of conventional design. Has many other profitable advantages. *Ask for complete information.*



This 80-ton HAULPAK performs at the Midland Electric Coal Company mine near Farmington, Illinois.

BIGGER PROFITS for you in well maintained haul roads

You can count on fast, low-cost haul-road maintenance when you use powerful heavy-duty LW graders. That's because LW graders work at higher speeds, complete jobs faster. Use them to build and maintain haul roads, level stockpiles and fills, improve drainage. LW graders last longer because of their 100% anti-friction drive and rugged one-piece main-frame. And you'll profit by the big 63-inch blade circle . . . the quick, easy moldboard tilt adjustment . . . rubber engine mounts . . . and full-sweep visibility. Seven models, 67 to 190 horsepower.

See color film "Revolution on Wheels"

In this 15-minute film you will see Haulpaks at work on highway construction, in copper and iron mines, and in rock quarries. You'll see why and how Haulpak moves more tonnage at big savings. Your LW Distributor will be happy to show you this film, "Revolution on Wheels".

Get complete facts on LeTourneau-Westinghouse equipment from your LW Distributor

Your nearby LW Distributor is ready, willing, and completely able to help you solve your hauling problems. He also handles LeTourneau-Westinghouse earthmoving equipment—Tournapulls, rubber-tired tractors, Rear-Dumps—and other lines of proven production tools. He is in a position to give you honest appraisal of trade-in equipment, and can assist you in obtaining helpful financing when it is needed.

See your Distributor, too, for dependable repair service and LW factory parts. You will be pleased with his prompt and efficient attention to your needs. Ask him to check your parts stock, and help arrange a schedule so his service department and yours can work together with greatest efficiency. You'll find your LW Distributor a good man to know. See him soon.

LW

Litho In U.S.A. LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILL. HP-2265-G-4

As Viewed by HENRY I. DWORSHAK of the American Mining Congress

POSSIBILITY of a general tax revision this year has been ruled out by a Congressional authority on this subject—Chairman Wilbur Mills (Dem., Ark.) of the House Ways and Means Committee.

Just before he rapped the gavel last month to close five weeks of Committee hearings on "broadening the tax base," Mills said it will not be possible for the Committee "to give specific consideration in 1960 to any broad proposals of tax revision based on these discussions." His statement has the ring of finality, for his Committee is the only one in either House or Senate authorized to initiate tax legislation.

Mills said he would request the staffs of the Joint Congressional Committee on Internal Revenue Taxation and the Treasury Department to analyze the testimony received at the hearings and submit to his Committee suggestions for tax revision—suggestions which would help broaden the tax base for the purpose of lowering tax rates, with due consideration to "their effect on fairness among taxpayers, on revenues, on economic growth, on economic stability, and on ability to pay."

However, Mills added, it will not be possible for the staffs to complete this analysis in the remainder of the 86th Congress, thus precluding any broad revision by Congress until 1961 at the earliest.

TRADE AGREEMENTS ACT HELD CONSTITUTIONAL

Congress did not violate the Constitution of the United States when, in the Trade Agreements Act of 1934, it delegated to the President authority to make reductions in import duties, the U. S. Court of Customs and Patent Appeals has ruled.

The unanimous ruling was handed down by the appellate court in upholding the dismissal by a lower Federal court of a suit brought by Star-Kist Foods, Inc. Star-Kist's suit asked that tariff reductions on tuna negotiated with other countries under the Trade Agreements Act be declared null and void because (1) the Act amounted to an unconstitutional delegation of legislative powers by Congress to the President, and (2) the tariff-cutting agreement actually was a treaty with a foreign nation which should have been ratified by the Senate.

Both arguments were rejected by the appellate court. It cited Supreme Court decisions which it said approved Congressional delegation of powers which are limited and which indicate the intent of Congress. In the 1934 Act, the court held, "the Congressional policy is pronounced very clearly. The stated objectives are to expand foreign markets for the products of the United States." These objectives, the court added, are in their nature no different than those of the Tariff Acts of 1890 and 1922, which the Supreme Court has upheld.

The decision may be appealed to the Supreme Court.

★ ★ ★ ★ ★ ★

Washington Highlights

TRADE ACT: Constitutionality upheld by appellate court

RESIDUAL OIL: Import quota hiked

STOCKPILING: Post-nuclear attack needs to be weighed

TAXATION: Court will review percentage depletion case

LEAD-ZINC: Escape-clause review petition is rejected

PUBLIC LANDS: Park Service seeks further withdrawals

CEMENT: Canadian dumping to be investigated

★ ★ ★ ★ ★ ★

GOVERNMENT BOOSTS CEILING ON RESIDUAL OIL IMPORTS

The Interior Department last month set the allowable residual fuel oil import level for the first six months of this year at an average of 425,000 barrels daily, an increase of 17 percent over the previous level of 363,433 barrels daily.

In announcing the hike, Interior Secretary Seaton said the situation with respect to supply and demand for residual fuel oil will be kept under close watch, "and if circumstances warrant, appropriate adjustments will be made."

Each individual importer may import all or any part of his allocation at any time during the six-month period, the Secretary said. He added that imports may be accelerated well above the daily average during the first months of the period if, in the judgment of the importer, his situation makes such action "prudent and necessary."

Joseph E. Moody, president of the National Coal Policy Conference, promptly registered a protest against the Department's action, stating that "all the data in our possession would indicate a reduction in quotas is in

order instead of the increase of 62,000 barrels a day. It is significant, we think, that the Department of the Interior has issued no explanation or justification of its action in increasing the quotas."

NEW STOCKPILING, DISPOSAL POLICIES ANNOUNCED

New Government policy on the stockpiling of strategic metals and other materials, recognizing for the first time reconstruction needs following a nuclear attack on the United States as a factor in setting stockpile objectives, has been announced by the Office of Civil and Defense Mobilization. This policy is set forth in Defense Mobilization Order V-7 as revised last month.

"Until such time as the essential needs of the nation in the event of a nuclear attack (including reconstruction) can be determined," the order states, "the maximum objective shall not be less than six months' usage by industry in the United States in periods of active demand."

All stockpile objectives have been limited since June 30, 1958, to meeting estimated shortages of materials for a three-year emergency. The "maximum objective" includes an additional allowance over the "basic objective" to take into account the complete discounting of sources of supply beyond North America and other "comparatively accessible areas." Basic objectives are to be attained "expeditiously," but procurement is to be tapered off as these objectives are approached, and maximum objectives are to be reached on a lower priority basis. Almost all basic objectives have been reached.

Incorporated in the revised order is current Government policy on disposal of materials in Government inventories. The order provides that "Disposal of materials that deteriorate, that are likely to become obsolete, that do not meet quality standards, or that do not have stockpile objectives, are to be expedited."

Disposal of such materials will be made to avoid "whenever possible" serious disruption of the usual markets of producers, processors, and consumers, according to the order.

COURT WILL REVIEW PERCENTAGE DEPLETION CASE

The U. S. Supreme Court has granted the Government's request to review the computation of percentage depletion in a case where the taxpayer mines fire clay and shale which he converts into vitrified sewer pipe, flue lining and related vitrified products. The case involved is *U. S.* v. *Cannelton Sewer Pipe Co.*, in which the Court of Appeals for the Seventh Circuit held that the taxpayer could base its depletion on the selling price of the finished products, because it could not sell its raw fire clay and shale at a profit. The Government is asking the Supreme Court to rule that "the commercially marketable product" for all mining taxpayers is the least processed product for the taxpayer's industry as a whole.

Because the Supreme Court's ruling might have wide application, the Government is expected to suspend administrative action on all claims for refund which are based on "cut-off point" decisions, pending issuance of the decision. While the Supreme Court has a large number of cases before it, there is a possibility that the decision will be rendered before the Court recesses next summer. In the meantime, little or no legislative activity is expected with respect to depletion "cut-off point" problems.

TARIFF COMMISSION REJECTS SMELTER PETITION

Less than a month after it was filed, the Tariff Commission rejected the request of six domestic lead-zinc smelting and refining companies for a formal review of the escape-clause action that resulted in the imposition in 1958 of annual quotas on imports of lead and zinc.

The petition urged that the Commission institute action leading to a rescission of the quotas, substituting therefor a reasonable increase in import duties. In rejecting it, the Commission said that Executive Order 10401, which established procedures for the type of review requested, provides that such a review be made only "Whenever in the judgment of the Tariff Commission conditions of competition with respect to the trade in the imported article and the like or directly competitive domestic product concerned have so changed as to warrant it, or upon the request of the President." No provision is made for formal review of escape-clause actions on the basis of applications or petitions by interested parties, the Commission added.

In compliance with a Senate resolution, the Commission is currently engaged in a broad investigation of the lead-zinc situation with a view to determining what additional import restrictions, if any, need to be imposed on lead and zinc, and on alloys and semimanufactured articles of these metals, "in order that lead and zinc mining operations in the United States may be conducted on a sound and stable basis."

The Commission said that the results of this investigation, which must be reported to the Senate by March 31, should also disclose whether conditions of competition with respect to the trade in imported and domestic lead and zinc appear to have so changed as to warrant a formal review of the escape-clause action.

NEW PARK AREAS SOUGHT

Two National Park Service proposals to further restrict multiple use of lands now open to mining location are under attack by mining industry representatives.

The Park Service seeks to close an additional 35,849 acres within Death Valley National Monument and also is supporting legislation to establish a new 147,000-acre Great Basin National Park southwest of Ely, Nev.

The closure of additional areas in Death Valley has been questioned by Chairman Aspinall (Dem., Colo.) of the House Interior Committee. Pointing out that Congress specifically provided that Death Valley National Monument be open to mining location, Aspinall asked Interior Secretary Seaton under what authority the additional withdrawals are to be made. The Department has informed Aspinall that this matter is now being studied by the Department's solicitor.

California mining interests have asked for a public hearing before any action to consummate the withdrawals is approved.

Senators Bible and Cannon (Dems., Nev.) heard local mining industry representatives testify at Ely last month against legislation to establish the Great Basin National Park unless the bill is amended to permit multiple use of the area, including the right to prospect for and develop mineral deposits. The Senators, both of whom sponsored the park proposal, indicated that they favor multiple use of the area regardless of its status.

CEMENT DUMPING TO BE PROBED

The Tariff Commission has announced that an investigation will be conducted to determine whether the domestic cement industry is being injured by imports of Portland cement manufactured by the St. Lawrence Cement Co., Ontario, Canada. The investigation stems from a determination by the Treasury Department that cement from the Canadian firm is being, or is likely to be, sold in the United States at less than fair value in violation of the Antidumping Act.

personals

Raymond E. Salvati, president of Island Creek Coal Co. and president of the American Mining Congress, has been named to receive the Erskine Ramsay Gold Medal of the American Institute of Mining, Metallurgical, and Petroleum Engineers. The award is being made to Salvati "for his outstanding contributions and achievements in the development and application of modern technology in underground coal mining and in the preparation of bituminous coal, and for his many years of distinguished leadership within the industry." He will be presented the medal at the institute's national convention in February.

Robert J. Linney, executive vice president and member of the executive committee, Reserve Mining Co., has been awarded the William Lawrence Saunders Gold Metal by the American Institute of Mining, Metallurgical, and Petroleum Engineers. The award, which recognizes distinguished achievement in mining other than coal, is to be presented to Linney "for administrative leadership and aggressive determination in bringing into successful commercial operation mining and beneficiation of taconite iron ore."

H. Preston Henshaw has been appointed special assistant in the office of the vice president, coal traffic and development, Chesapeake and Ohio Railway.

Emmett G. Solomon, vice president and director, Bunker Hill Co., will serve as chief executive officer and chairman of the executive committee pending appointment of a new president to succeed the late John D. Bradley. **Ross D. Liesk,** director, has been appointed to the vacancy on the executive committee created by Mr. Bradley's death.

Officers for the year 1960 have been elected by the West Virginia Coal Mining Institute. **S. Dunlap Brady, Jr.,** consulting mining engineer, Baltimore & Ohio Railroad Co., was elected president. Other officers include five vice presidents: **Stephen Canonico,** vice president, Clinchfield Coal Co.; **Joseph L. McQuade,** president, Donegan Coal & Coke Co.; **N. T. Camicia,** manager, Island Creek Coal Co.; **Harold Suter,** vice president, Christopher Coal Co., and **David C. Ridenour,** general superintendent, Olga Coal Co.

Eugene B. Hotchkiss was recently named executive vice president of Vitro Minerals Corp. Hotchkiss is also a director of the company, which he joined in 1953.

D. E. Lutz of Jewell Ridge Coal Sales Co. has been appointed assistant general sales manager, industrial sales, in the Cincinnati, Ohio, area. At the same time **W. C. Whittaker, Jr.,** becomes assistant general sales manager, retail and lake sales, and **Rex H. Ritter,** manager in charge of the Ohio and Southern Indiana territories.

H. Taylor

E. W. Sloan, Jr. has been elected to succeed **Harris S. Taylor** as president of Oglebay Norton Co. Taylor was named vice chairman of the company after having served as president since 1949. He joined Oglebay Norton in 1936. Sloan had been executive vice president since 1956 and previous to that was a director and vice president.

Charles C. Cannon has been appointed division manager in the Detroit office of Princess Coal Sales Co., the sales affiliate of Princess Coals, Inc.

Evan Hall has been appointed assistant plant manager for Calaveras Cement Co. at its San Andreas, Calif., plant. Hall, who was formerly mill superintendent, succeeds the late Tom Love. **David Cosgrove** will fill the vacancy created by Hall's advancement.

John M. Morris has been elected president of the United Electric Coal Companies. **Frank F. Kolbe** was named chairman of the board, while **R. S. Hepburn** was elected vice president—operations, and **Thomas J. Tarzy,** vice president sales.

J. Morris

F. Kolbe

William T. Ennor has retired as assistant director of research for Aluminum Co. of America after 35 years of service with the company.

Lockwood W. Ferris has resigned as president of Bonneville, Ltd., to do metallurgical and chemical engineering consulting work.

Carl A. Wallerstedt recently retired as manager of the Waco, Texas plant of Universal Atlas Cement Division of U. S. Steel after 40 years of service. Wallerstedt had been plant manager at Waco since 1928 and has been succeeded in that position by **Ray Graves,** formerly administrative assistant-operating at the company's New York headquarters. Graves joined Universal Atlas in 1926.

C. Fred Borden recently became executive vice president of Kaiser Steel Corp. He had been vice president in charge of sales for Kaiser since 1950.

Spencer S. Shannon resigned as director of the Office of Minerals Mobilization, Department of the Interior, December 31, after 4½ years with the agency. Before becoming director of OMM, Shannon had worked as a mining consultant and had served in various Government posts since 1939. Prior to 1939, he was associated with Carbon Coal & Coke Co. and the Shannon Co.

Allan D. Gray, president of the Susquehanna-Western, Inc., has been elected a director of the parent Susquehanna Corp. Susquehanna-Western operates a uranium mill and sulphuric acid plant at Riverton, Wyo., and a uranium mill at Edgemont, S. D.

William B. York is now smelter maintenance superintendent, Utah Copper Division, Kennecott Copper Corp. Division industrial engineer since April 1958, York joined Kennecott in July 1957. **B. Blain Bradford** succeeds York as division industrial engineer at Utah Copper, a position similar to his previous job as division industrial engineer, Nevada Mines Division.

Other Utah Copper Division personnel changes include naming **Karl H. Koropp,** superintendent of operations, Garfield refinery, to the position of project engineer for the Western mining divisions. Koropp's successor is **C. Arthur Feldin,** formerly with the company's research office in the product development department.

Newly elected officers for the Southern Appalachian Coal Operators' Association include: **C. R. Griffith,** Southern Coal & Coke Co., president; **Fred Loving, Jr.,** Kentucky Ridge Coal Co., first vice president; and **P. B. C. Smith,** Pocahontas Fuel Co., second vice president.

Paul R. Kruesi has become vice president in charge of research and development, Vitro Chemical Co. He had been general manager of Heavy Minerals Co., recently absorbed by Vitro Chemical. **R. N. Miller** has been named acting plant manager to succeed Kruesi. Miller was formerly with Vitro Uranium Co. which was also absorbed by Vitro Chemical.

L. B. Rahn, assistant general sales manager of Peabody Coal Co. for the past five years, has been appointed a vice president–sales.

Michael P. W. Stone has been named to the newly created post of director of corporate development, Utah Construction & Mining Co.

Kenneth Lieber, vice president of Cyprus Mines Corp., is now a director of the company.

Orval Webster Adams, Jr., was recently appointed administrative assistant to the president, Hidden Splendor Mining Co. Adams had previously been attorney for the Utah Legislative Conference for two years.

S. S. Shattuck has resigned as vice president and a member of the board of directors of Shattuck Denn Mining Co.

OBITUARIES

Rudolph T. Elstad, 64, president of Oliver Iron Mining Division, U. S. Steel Corp. died December 14 in Duluth, Minn.

Mr. Elstad joined Oliver Iron Mining Co. in 1919 as a mining engineer and in the ensuing years advanced successively to mining captain, assistant superintendent, assistant to the vice president, vice president and was made president in 1946. He had been a director of the American Mining Congress since 1951.

Widely recognized for his professional leadership, Mr. Elstad was an authority on all phases of iron ore production, and his wise council will be sorely missed by his many friends and business associates. Interested, too, in civic affairs, he was a member and past vice president and director of the Duluth Chamber of Commerce, director of the Duluth Rotary Club, and a member of the American Institute of Mining Metallurgical and Petroleum Engineers and the American Iron and Steel Institute. He was also a trustee of Carleton College.

Harry S. Homan, 72, executive secretary of the Southern Appalachian Coal Operators Association, died in Knoxville, Tenn., November 15.

Mr. Homan had been with the Southern Appalachian group for eight years and previously had been executive secretary of the Big Sandy-Elkhorn Coal Operators Association at Pikeville, Ky.

John D. Bradley, 49, president and director of the Bunker Hill Co., was killed in a California automobile accident, that also claimed the life of his wife Jane, on November 26.

Mr. Bradley, widely known as head of the nation's second largest lead producer, had become president of Bunker Hill in 1955. He joined Bunker Hill in 1933 as an underground surveyor. Following employment as superintendent of the Spanish mine in California he served as executive vice president and director of Bradley Mining Co., in charge of the company's Idaho operations.

By 1940 his work was devoted largely to development of the Yellow Pine mine at Stibnite, Idaho, which was the nation's largest tungsten and antimony producer during World War II. In 1954 Mr. Bradley was named executive vice president of Bunker Hill.

At the time of his death, he was serving as president and chairman of the board, National Lead Industries Association; director, American Zinc Institute and as a member of the Board of Governors, American Mining Congress.

William J. Hutchinson, 75, a director and retired treasurer of International Nickel Company of Canada, Ltd., and International Nickel Co., its United States subsidiary, died November 25 in New York City. Mr. Hutchinson was also a director of American Potash and Chemical Corp.

Perry G. Harrison, 74, well known mining executive and a director of M. A. Hanna Co., died in Cleveland, Ohio, November 11. Mr. Harrison was president of Evergreen Mining Co. when it was acquired in 1946 by M. A. Hanna Co. He subsequently served as vice president of Hanna Mining Co. and ore sales manager of M. A. Hanna until he retired in 1957.

Orvil R. Whitaker, 84, a consulting mining engineer, died November 26 in Denver.

Mr. Whitaker began his mining career in 1898 and spent the next 14 years working in Mexico, Canada, Central America and the United States after which he became a consultant. He was named to the Raw Materials Advisory Committee of the Atomic Energy Commission upon its creation in 1948. At one time during his career he had been a trustee of the Colorado School of Mines and received an Award of Merit from the school in 1942.

Robert C. Norton, 79, honorary chairman of the board of directors, Oglebay Norton Co., died November 22 in Cleveland, Ohio.

Mr. Norton, son of one of the founders of Oglebay Norton, had been associated with the company for 40 years.

NEWS and views

Eastern

Call for Teamwork in Supplying Coal Cars

In a recent open letter setting forth important considerations in evaluating railroad freight car supply, Howard E. Simpson, president of B&O Railroad Co., pointed out that the times called for teamwork between the users and providers of railroad freight service. The present serviceable supply of railroad freight cars can be greatly improved if railroads will move them faster and if shippers and receivers will load and unload promptly and consider each car as a costly tool of transportation.

In referring to B&O in particular, Simpson said that the movement of coal is of prime concern to this company, which has more than $300,000,000 invested in fixed plant, locomotives and cars used chiefly for coal traffic—including more than 47,000 hopper cars. Pledging future cooperation, he recounted past efforts to cooperate. For example, although the work stoppage in the steel industry reduced the B&O's revenue by some $30,000,000, in September it recalled 625 car repairmen; in October, 614; and in November, 375, a total of 2214. As a result of this effort, by the end of 1959 the company had increased the number of serviceable hopper cars by 3500 units, and, in addition, 2500 freight cars of other types.

Due to the urgency of moving iron ore now in ground storage to the steel mills, the B&O has secured 1300 cars from Western roads at a rental of $3700 per day. These cars will release a similar number of cars for the increased movement of coal.

It should also be pointed out that in the last four years B&O has spent more than $100,000,000 in the purchase, rebuilding and repair of hopper cars. Presently the cost of one 70-ton hopper car is over $10,000, or more than twice as much as in 1946. During the same period B&O freight rates on coal have risen 68.8 percent.

Simpson represents 30 coal-carrying railroads on the recently formed National Coal Policy Conference, comprising coal operators, the United Mine Workers, electric utilities and coal mining equipment manufacturers. This group's objective is the adoption of a national fuels policy by the Congress which will recognize the proper place of bituminous coal in the Nation's economy. On behalf of this Conference, he has publicized widely the fact that if coal markets and production continue to shrink, the enormous railroad plant dedicated to transporting this commodity will be seriously affected. He has further emphasized that neither the bituminous coal industry nor the railroads can afford to maintain standby service.

Work Progressing on Humboldt Pelletizing Plant

A contract for fabrication of 35 conveyor units for the new Humboldt Mining Co. iron ore pelletizing plant at Humboldt, Mich., has been awarded to Lake Shore, Inc. The heavy-duty conveyor systems will be 850 ft long, and will use 1852 ft of belting. Special belting will run in

(*Continued next page*)

John L. Lewis to Resign as UMWA Chief

On December 15, 1959, John L. Lewis announced he would resign as president of the United Mine Workers of America "shortly after the New Year." He disclosed his unexpected move in a letter to members of his union which was published in the United Mine Workers Journal.

J. Lewis

T. Kennedy

Thomas Kennedy, UMW vice president and former lieutenant governor of Pennsylvania, will succeed him. A product of Pennsylvania's hard coal fields, Kennedy has been a national officer in the mine union since 1925.

In stepping down from the post he has held since 1919, Lewis said, "Every logical circumstance leads to the conclusion that I should begin the transfer of my obligations and duties to other and more capable hands." After summarizing the gains made by the Mine Workers Union during the years of his stewardship, Lewis said in his letter that he hoped the Union's convention next October would grant him an "honorable discharge" from his duties.

One of America's most distinguished labor leaders and father of the CIO, Lewis is also one of the vice chairmen of the National Coal Policy Conference, Inc., a labor-industry-consumer organization composed of operating companies in the coal industry, the UMWA, the electric utility companies, coal equipment manufacturers and major coal-originating and coal carrying railroads. The NCPC is the outgrowth of a proposal made on May 5, 1958, by Lewis to the Coal Convention of the American Mining Congress in Cincinnati. In that speech he called for the creation of a "central organization—nontechnical—to deal with our national problems, the public interest and over-all questions incident to continued existence that are not in themselves specialized or technical."

(*Continued from previous page*)
lengths up to 49 ft and widths of up to nine ft to handle the pelletized ore.

The 2000 tpd plant is the first low grade iron ore pelletizing plant to be constructed on the Michigan iron range and is scheduled to be in operation in mid-1960. Humboldt is jointly owned by Ford Motor Co. and Cleveland Cliffs Iron Co.

Nuclear Energy for Coal Gasification

The U. S. Bureau of Mines has developed a pressure-process for the continuous production of synthesis gas from coal, steam, and oxygen. Actually, only coal and steam are needed to produce synthesis gas, but oxygen is provided for the combustion of a certain amount of the coal to supply heat for the endothermic steam-coal reaction. The additional cost of the coal and the oxygen, including the cost of oxygen compression, makes the gasification process uneconomical at present. If an economical process is to be developed, cheaper heat must be obtained from other sources.

An attractive potential source for the energy required is heat from nuclear fission. As part of a Bureau investigation of the application of heat from nuclear fission to coal gasification and chemical processing, a simulated-nuclear system has been designed and constructed in which heat is produced by electric induction to circumvent the complications of radioactivity. Heat—generated within a bed of graphite spheres that simulate nuclear fuel-elements—is transferred to a pressurized stream of recycled helium gas, which, in turn, can heat chemical processing streams to 2000°F. Having demonstrated the feasibility of gasifying sub-bituminous coals and lignite in alloy-steel tube-coil gasifiers at about 1800°F, the Bureau conceives a "nuclear-energy" gasifier as the heat exchanger in this system. The operating temperature of the gasifier need not exceed 1800°F. for low-rank coals, but higher temperatures indigenous to process-heat reactors would materially aid the process.

Objectives of the design and construction of the prototype unit are twofold: (1) To divulge and solve the engineering problems relative to the design, construction, and operation of the system, and apply this information to the development of nuclear process-heat technology, and (2) to obtain information for the design, construction, and operation of a coal gasifier that can supply nuclear-derived heat to a steam-coal mixture with essentially no radioactivity imparted to the product gas.

Penn State Awarded Research Grant

A National Science Foundation grant for research in mining engineering has been awarded to the Pennsylvania State University. Dr. Howard L. Hartman, professor and head of the Department of Mining, is the recipient of the three-year, $32,600 grant to study the mechanics of brittle fracture in rock under impact loading.

The purpose of the research, being conducted in Penn State's rock mechanics laboratory, is to discover the mode and sequence of rock failure under an impact blow, such as employed in percussion drilling. Although rock drills have been used in mining for almost 100 years, their basic action in penetrating rock in the drill hole is not well understood. Admittedly an inefficient process, probably of the order of one to two percent, improvements in rate of penetration and bit life depend upon increasing the knowledge of the basic cutting action.

M & T Expands Mining Operations in Virginia

Expansion of operations in an an 800-acre tract at Hanover County, Va., has been announced by Metals & Minerals Division, Metal & Thermit Corp.

A continuing company program to develop the property has proven that substantial quantities of aplite are present in the ore body. Aplite is one of a group of minerals used by the glass industry as a source of alumina for the production of colored and flint container and window glasses. Installation of equipment to modify existing ore processing facilities at Hanover for production of aplite has been started, and the company anticipates that commercial quantities of the material will be available by June 1960.

M & T opened its Hanover mine approximately two years ago to renew rutile and ilmenite mining operations which were originally carried on at Roseland, Va., approximately 80 miles from the present site. Since that time, the company has determined that, in addition to rutile and ilmenite, commercial quantities of aplite, mica and sphene are present.

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Philadelphia and Reading to Move Into Chemical Industry

Philadelphia & Reading Corp. is moving forward with plans to enter the chemical industry. The 1000-acre site for the joint venture with General Dynamics Corp. has been selected near Pottsville, Pa. The principal raw material is anthracite waste —estimated to total 300,000,000 tons —which has been accumulating over many decades and heretofore considered virtually worthless. The plant will produce various hydrogen-based chemicals as well as varied carbide chemicals.

In regard to the status of the chemical operation, Howard A. Newman, president of Philadelphia & Reading, recently stated that; "(1) final tests in Lurgi gasifiers and carbide furnaces in Europe have been completed. The results of these tests are now undergoing final evaluation with particular emphasis on pinpointing the capital required for plant construction. (2) Negotiations are under way with many prospective customers looking toward finalization of mutual commitments with respect to long term contracts for distribution of products. (3) Dependent upon the answers, we will be able to make a final determination as to quantities of products to be produced. It looks at present as though the entire complex will be set up to produce 50,000,000 cu ft per day of hydrogen and synthesis gas; a substantial tonnage of calcium carbide and supply steam to a large integrated power station. Part of the plant may be in production 18 months following the start of construction (ground breaking is expected in early spring) but it will probably take close to three years before full production is achieved."

Peabody Buys Maumee

Peabody Coal Co., St. Louis, Mo., has purchased the properties of Maumee Collieries Co., which operates four coal mines near Terre Haute, Ind. Termed a "several million dollar purchase," it is part of Peabody's long range plans for replacing operations which are mined out and closed from time to time and to replenish the company's coal reserves.

Maumee produced about 1,650,000 tons last year and has reserves of about 100,000,000.

Hugh B. Lee, Jr., president of Maumee, has been named a sales vice president of Peabody.

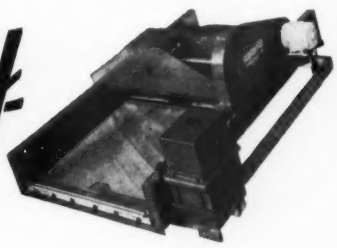
Copper Range Acquires Interest in Alloyd

Copper Range Co. has acquired a substantial interest in the Alloyd Corp., a metals and materials research and development concern in Watertown, Mass.

Alloyd, organized in 1955 by a group of M.I.T. scientists, performs research and development work for the Army, Navy, Air Force, Atomic Energy Commission and many top industrial concerns. The company's major efforts are directed toward the solution of problems posed by high performance devices which require metals and other materials with properties presently unattainable.

Copper Range's subsidiary, White Pine Copper Co., located at White Pine, Mich., operates a copper mine producing upwards of 45,000 tons annually. Its rolling mill division, C. G. Hussey & Co., produces a wide variety of sheet, roll and strip copper and merchandises a complete line of brass mill products through its branch warehouse system.

THE Leahy HEAVY DUTY VIBRATING SCREEN



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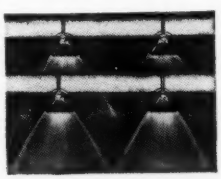

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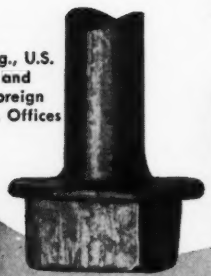
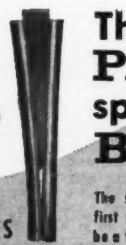


The PATTIN split-type BOLT



The split-type bolt is one of the first slotted bolts, and continues to be a favorite wherever split-type bolts are used. Many mines still prefer this type. The bolt is a full 1-inch in diameter, with cut threads and furnished with hex or square nuts and various size plates and wedges.

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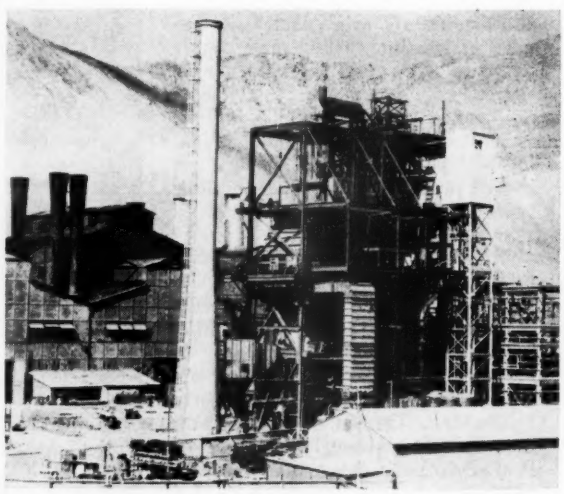
ALSO . . .

Oliver Mining Division of U. S. Steel Corp. has disclosed it will build a new plant on the Minnesota iron range to concentrate low grade ore taken from mines than cannot now compete with quality producers. The new plant, between Chisholm and Buhl, will process ores from the Sherman and Monroe mine group. The facility will have a capacity of about 1,500,000 tons of concentrates annually.

Reynolds Metals Co. bauxite from Haiti will be delivered during 1960 to a U. S. Government stockpile, in exchange for high protein wheat to be consumed by Caribbean Mills, Inc., in Haiti. About 400,000 tons of bauxite is involved. The barter arrangement will enable Reynolds to step up its operations in Haiti to full capacity during the year.

Oglebay Norton Co. of Cleveland, Ohio, recent purchasers of the West Virginia holdings of Truax-Traer Coal Co., has announced the closing of three Coal River area mines in West Virginia. The operation at Marfork along with the Shamrock and No. 5 operations at Kayford were closed by this decision.

Bethlehem Steel Corp. recently launched a new 730-ft ore carrier. Named for the president of Bethlehem Steel, Arthur B. Homer, the boat was designed to bring ore down the lakes from the Duluth area and also to navigate the Seaway to the ore loading docks at Seven Islands, Quebec. With carrying capacity of more than 25,000 gross tons of ore, the **Homer** will join the lake fleet operated by Bethlehem Transportation Co.



A 375,000 lb capacity steam boiler is pictured in the erection stage at Tocopilla, Chile, site of a large copper refining plant of the Chile Exploration Co., a subsidiary of Anaconda Copper Co. When completely installed, the unit, which was manufactured by Babcock & Wilcox Co., will be the tallest structure in northern Chile. Total power of the plant's generating system will be increased to 150,000 kw per hr when the new equipment goes on stream. Costing more than $1,000,000, the boiler is a major part of an $8,000,000 plant expansion. Closed circuit industrial television—Chile's first—will be a notable feature of the boiler installation

The Ninth National Clay Conference will be held at Purdue University, Lafayette, Ind., on October 6, 7, and 8, 1960, under the auspices of the Clay Minerals Committee of the National Academy of Sciences-National Research Council. Two symposia of invited papers will be held on the topics of "Engineering Aspects of Physico-Chemical Properties of Clays" and "Clay-Organic Complexes." In addition to these special symposia there will be general sessions of contributed papers. All those having contributions should contact Dr. J. L. White, chairman, Ninth National Clay Conference, Agronomy Dept., Purdue University, Lafayette, Ind. The title and an abstract of approximately 250 words should be sent in by June 1.

Lone Star Cement Co. has announced plans for a $6,500,000 expansion of its cement plant at Norfolk, Va. Major item in the program is a new kiln, expected to boost plant capacity by about 1,000,000 bbls a year.

A new, electronic metallurgical searching service with a 100,000 titles-per-hour capacity will be launched early this year by American Society for Metals, Novelty, Ohio. The searching project will supply subscribers with titles and information about documents reporting on any aspect of metallurgical science, engineering and the fabrication and use of metal parts that appear in the world's literature. The new ASM service will be beneficial to those isolated from libraries. It will aid research laboratories, libraries, governmental agencies, engineering and scientific bodies, plus numerous other organizations requiring broad specific metals information.

Texas Gulf Sulphur Co. is conducting studies at Lincolnton, N. C., in an effort to determine if a multimillion dollar lithium plant would be feasible in that area. Lithium bearing spodumene ore reserves are being tested. In addition, the company is trying out a pilot refining process patented by Basic Atomics Inc. Texas Gulf, which has an option on the Basic Atomic method, also has five-year options on over 1000 acres of potential mining properties owned by Basic Atomics.

White Pine Copper Co. has announced the discovery of a new copper ore deposit in Michigan's upper peninsula about 17 miles southwest of Ontonagon. The extent of the new deposit, which is on the company's property immediately west of its current mining site, won't be determined until exploratory shafts have been sunk. White Pine is owned by Copper Range Co.

A meeting of the Fred J. Bailey Post No. 4 of the National Mine Rescue Association was held December 5, 1959, at West Frankfort, Ill. Speakers included: (left to right) C. C. Quirey, superintendent, Pittsburg & Midway Coal Mining Co.; Sanford Douglas, electrical engineer, U. S. Bureau of Mines; Everett Bayless, foreman, Old Ben Coal Corp.; George Guiney, inspector at-large, Illinois Department of Mines & Minerals; James Phalan, chief, Kentucky Department of Mines & Minerals; Tom Garwood, assistant vice president in charge of operations, Freeman Coal Mining Corp., and Coy L. South, safety director, Bell & Zoller Coal Co. Also on the program, but not shown, was Frank Rolisek, safety director, Freeman Coal Mining Corp.

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NEWS and views

Ideal Cement Plant Dedicated

Ideal Cement Co. recently dedicated its new $20,000,000 cement plant at Ada, Okla. One step in a ten-year, $176,000,000 expansion and modernization program announced in 1955, the new plant has a capacity in excess of 3,000,000 bbls per year. Reportedly one of the most highly instrumented and mechanized plants in the world, it makes extensive use of prestressed and precast concrete support members throughout. Equipment includes two 450 by 12-ft diam rotary kilns and nine 140-ft high by 36-ft diam cement storage silos. A 5½-mile belt conveyor system from the company's Lawrence quarry is considered to be the world's longest permanently installed cross country belt system. Ideal's Ada plants have a combined annual capacity of 5,500,000 bbl bringing the company total annual capacity to 37,000,000 bbl.

$20,000,000 Iron and Steel Plant Under Construction

Western Canada's first integrated iron and steel operation is slated to go into production by May 1961 at Kimberley, B. C. Consolidated Mining & Smelting Co. of Canada is building a 36,500-ton per year capacity electric pig iron smelter in the first phase of a two-phase project. The second phase calls for increasing annual capacity to 100,000 tons of pig iron, ingots and rolled steel products by May 1964. Smelter feed will come from tailings from Cominco's Sullivan mine which reportedly contain in excess of 15,000,000 tons of recoverable iron. The company will utilize coal, coke and limestone from the Crowsnest Pass area and power resources of the Kootenay and Pend Oreille Rivers in their electro-metallurgical process. A performance bond has been posted with the Provincial Government that guarantees completion of a $20,000,000 plant by May 1964. The operation will eventually employ about 200 men.

Shiprock Mill Uranium Contract Extended

The U. S. Atomic Energy Commission and Kerr-McGee Oil Industries, Inc. recently signed an extended uranium concentrate purchase contract calling for continued operation of the company's 300-tpd uranium processing mill at Shiprock, N. M. Extension of the contract to June 30, 1965, or to an earlier date when Kerr-McGee will have delivered the maximum number of pounds of uranium concentrates to the Commission, is in accordance with a November 1958 AEC announcement governing future purchase contracts from established reserves. Kerr-McGee has been delivering yellowcake to the Commission since January 1955. The Shiprock mill currently is being expanded to provide a solvent extraction circuit to recover high purity vanadium concentrate (about 99 percent V_2O_5) as well as uranium concentrate from Shiprock ores.

Alcoa Will Have Interest in Mexican Aluminum Plant

Mexico's first primary aluminum smelting plant will be constructed in the state of Veracruz. Aluminum Company of America has joined with two groups of Mexican and European investors in plans requiring the expenditure of $20,000,000 to erect a 20,000-metric ton per year plant scheduled to be in production in two years.

The plant will be operated by Aluminio, S. A., a new company in which Alcoa will have a 35 percent interest. A ten percent interest will be held by the European group and the remaining 55 percent by Intercontinental, S. A., a Mexican investment bank and a group of other Mexican investors.

Ocean going barges will serve the plant site and electrical energy will be obtained from a government hydroelectric plant.

ALSO . . .

An Arizona company, Transarizona Resources, Inc., is reportedly planning to utilize a segregation process for treating oxidized and mixed oxide-sulfide copper ores from an open pit operation near Casa Grande, Ariz. The process, which has been the subject of U. S. Bureau of Mines research work, remains to be proven commercially feasible. In it, crushed ore is heated with salt and coke or other carbonaceous material at about 700° C to produce fine flake copper which is recovered by conventional copper flotation methods. Transarizona is proceeding with stripping operations and plans to be producing 500 tpd from their open pit by spring. Controlling interest in the Arizona company is held by Transcontinental Resources, Ltd., a Canadian corporation.

The U. S. Bureau of Mines has presented a safety award to the ore mining department of Lone Star Steel Co. in recognition of 220,000 man-hours worked in 1958 without a lost time accident.

A major expansion is being planned for National Gypsum Company's Rotan, Texas, gypsum building products plant. The expansion program, which will begin in the spring, will increase capacity to where the completed plant will produce enough wallboard, lath, plaster and other gypsum products for 75,000 homes annually. The company forecasts increased operations at their gypsum mining operation upon completion of the project in the fall of 1960.

A continuation of previous studies on carbonization of western

coal to make synthetic coke will be made possible by a grant to the University of Wyoming. Union Pacific Railroad has awarded the university a $20,000 research grant that will be aimed at developing an economical coke substitute that could utilize western coal in its production.

A 500-tpd plant for production of sponge iron through a direct reduction process is being completed at Monterrey, Mexico, for Fierro Esponja. Known as the Hy L process, iron ore is reduced when brought into contact with hot reformed natural gas in batch-type reactors. The process was developed by Hojalata y Lamina, a leading Mexican steel producer, with engineering assistance from M. W. Kellogg Co. Fierro Esponja currently is operating a similar 200-tpd plant adjacent to the new facility which is being built by Kellogg.

In a move to consolidate its holdings in the Butte, Mont., area, Anaconda Co. is reportedly acquiring all assets of Butte Copper and Zinc Co. for a consideration of $1,325,000. The latter company's board of directors has authorized the sale, which is subject to approval of stockholders, that would terminate a joint operating agreement with Anaconda.

Huge potash deposits in the Cane Creek area near Moab, Utah will be developed according to plans of Delhi-Taylor Oil Co. Delhi-Taylor has been establishing the Cane Creek reserves over the past several years and recent negotiations for marketing the potash indicate that the deposits will be opened up in the near future. It is expected that about two years would be required for development before mining on a 1000 tpd basis could begin.

Calera Mining Co. has closed permanently its Garfield refining plant near Black Rock, Utah, which for the past eight years has been processing cobalt. Closure marked the end of a contract with the General Services Administration. The plant and equipment have been put up for sale.

Eagle-Picher Mining Co. has proposed to the Quapaw Indian owners of closed lead-zinc mines in the Tri-State area a measure that could lead to reopening of the mines. The proposal calls for decreased royalty payments to the Quapaw's that would permit profitable operations under existing lead and zinc prices. The mines have been closed for two years.

High-purity white glass sand will be produced from silica-clay sands at the J. R. Simplot Co. plant now nearing completion at Bovill, Idaho. The facility, which represents an investment in excess of $1,500,000, will handle about 500 tpd. First production will be white glass sand to be followed by clays for paper coating and filling.

All assets of White Canyon Mining Co. will be absorbed by Yuba Consolidated Industries, Inc. under an agreement subject to approval by White Canyon shareholders. White Canyon has been engaged for several years in uranium mining and owns 370 claims in San Juan County, Utah, as well as leases on about 23,000 acres of gas and oil lands.

An estimated 1,800,000 tons of ore averaging 1.6 per cent copper on properties owned by Banner Mining Co. will be mined by Pima Mining Co. in an open pit operation near Tucson, Ariz. Until recently the companies had been unable to reach agreement on mining ores of both firms on properties sharing a common boundary. Under the agreement, which covers a nine-year period, Pima will mine Banner ore for the Banner account at cost of operation. However, immediate work calls for extensive stripping at the properties before ore mining can proceed.

Fifteen men are working toward reopening, on a limited basis, the Calvert tungsten mine in Beaverhead County, Mont. Minerals Engineering Co., which owns the tungsten property, will operate its Glen, Mont., mill at a rate of about 5000 tons per month. This will furnish the company's Salt Lake City plant with its immediate tungsten needs for the manufacture of ammonium paratungstate.

Production of electrolytic zinc from the Bunker Hill Co. plant at Kellogg, Idaho, is being upped 14,000 tons for a total annual rate of 74,000 tons. This follows reactivation of the company's fifth processing unit which has been shut down for the past two years. The production boost requires adding about 40 men to the payrolls.

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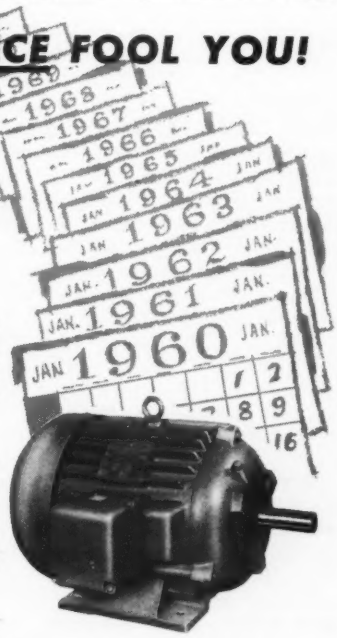

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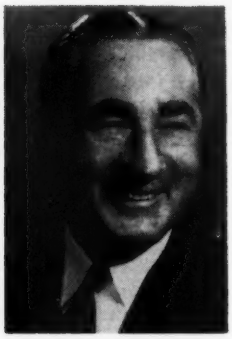

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Manufacturers' Division Chairman

1960 MINING SHOW

Las Vegas, With A Brand New Exhibit Hall, Will Be Host To AMC Metal Mining and Industrial Minerals Show, October 10 to 13, 1960

JOHN C. KINNEAR, JR., general manager of Nevada Mines Division, Kennecott Copper Corp., as Chairman of the Western Division of the American Mining Congress is digging right into the task of organizing for the 1960 AMC Mining Show to be held in Las Vegas. Acceptance of the Program Committee chairmanship by Oscar A. Glaeser, vice president and general manager, western operations, U. S. Smelting, Refining & Mining Co., was a major step forward in preparing for the October 10 to 13 Convention.

Albert E. Seep, president, Mine & Smelter Supply Co. and chairman of the AMC Manufacturers Division, will play an important part in the exposition of mining equipment. Applications for exhibit space in the new Las Vegas Convention Center—including the main exhibit halls, the picturesque arena and its concourse, and a generous outdoor space for extra-large equipment—have been particularly heavy. Because of the excellent, spacious facilities, however, it is expected that there will be adequate room for all exhibitors.

Assisting Mr. Kinnear as co-chairman of the General Arrangements Committee will be A. E. Millar, general manager of Anaconda's Yerington Mine, and Louis D. Gordon, long prominent in Nevada mining circles, will serve as Secretary. These top leaders have been busy lining up the various special committees for the meeting—including Welcoming, Publicity and Trips—and these appointments will be announced later.

A special program for the ladies will, of course, be arranged again this year by the Ladies Hospitality Committee, which is headed by Mrs. Joseph Wells of Las Vegas.

The Program Committee under Oscar Glaeser's chairmanship is entrusted with the job of developing the various convention sessions, on both policy and technical matters. With far-reaching developments taking place in technological, legislative and economic matters of vital concern, the 1960 Convention and Exposition promises to be an event of major importance to the mining industry. The industry's current problems and latest accomplishments will be discussed by leading authorities in every field.

The exhibits of new mining machines, equipment and supplies will be of immeasurable value to mining men, from the production worker at the face to the top executive. There is no comparable opportunity for mining officials, operators, engineers, technicians and supervisors to see so much of the latest machinery that makes possible the progress of our mineral industries.

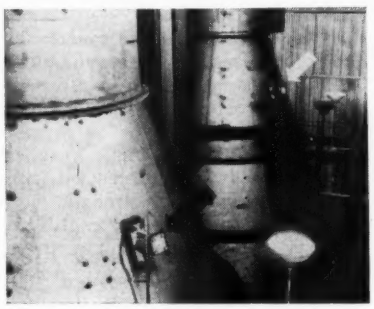
Those who attended the 1955 AMC Convention in Las Vegas are aware of the excellent hotel, dining, and entertainment facilities of this fabulous city. Although a larger attendance is certain to be on hand for this year's convention and exposition, expanded hotel facilities indicate that there will be room for all comers. All hotel reservations will be handled through an AMC Housing Bureau operated by the Las Vegas Convention Bureau. Reservation forms will be sent out with the first general publicity release, about the middle of February.

manufacturers forum

Air Vibrators

THE UNIFORM MOVEMENT OF IRON ORE through sintering and stock-house bins, even with moisture as high as 16 percent is said by Air Vibrator Co., 435 Literary Rd., Cleveland 13, Ohio, to be the purpose of the special design behind its newly announced BH-4 "Long-Stroke" Air Vibrator.

This equipment has a 30-lb "long piston stroke" that strikes the bin with a timed impact—dislodging arched



material instead of packing it. The Vibrator has a patented "one-piece" construction, uses no body assembly bolts to shear or stretch, and no separate striking plate. Piston is the only moving part. The manufacturer states that ore fines, dust and moisture have no effect on successful operation of the unit.

The BH-4 weighs 105 lbs, measures 12¼ in. by 16 in. by 6½ in., and averages operating air pressure ranges from 45 to 65 psi.

High Capacity Conveyor

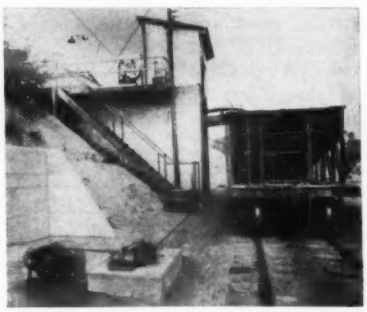
DESIGNED PRIMARILY TO WORK WITH AUGER DRILLS in the mining of coal, a high capacity conveyor, up to 210 tph, has been announced by Fairfield Engineering Co., Marion, Ohio. It can be attached to the auger so that it moves as the auger is moved to the next location. The conveyor is rubber mounted and has discharge heights ranging from 10 to 17 ft. Flight speed is 120 fpm. Optional features include hydraulic steering, hoisting and chute swing. A choice of electric motor, gasoline or diesel engine is available to fit the job and location.

Tractor Maintenance Tools

TO SERVICE INDUSTRIAL CRAWLER TRACTORS and earth moving equipment, a set (No. Y-1750) of hydraulically operated maintenance tools has been announced by Owatonna Tool Co., Owatonna, Minn. It includes pullers, attachments and adapters to fit all types of equipment, plus 17½ and 50-ton OTC Power-Twin hydraulic units which can be used on other hydraulic equipment as well. The set is said to ease such maintenance operations as removal and installation of gears, bearings, sheaves, pulleys, bearing cups, shafts, couplings and other tightly fitting parts.

Car Puller

AFFORDING GREATER SAFETY TO OPERATING PERSONNEL and bringing the power of a locomotive to one-man car spotting jobs are said to be the advantages of the No. 14H car puller developed by engineers of Stephens-Adamson Mfg. Co., Ridgeway Ave., Aurora, Ill. There are no ropes to snub and the operator does not have to maintain tension or coil rope. The car puller is totally en-



closed, fully protecting the operator from moving parts, is weather-tight and requires no special housing. Available as optional equipment is a fluid coupling motor to sustain greater shock load.

Truck Crane for Drop-Ball Secondary Fragmentation

THE 40-TON P & H 565A-TC is one of five truck crane models introduced by Harnischfeger Corp., 4400 West National Ave., Milwaukee 46, Wis. A popular application of this model is drop-ball secondary fragmentation of preblasted material in quarrying and open pit mining.

The unit employs Magnetorque, a patented method of transmitting power electro-magnetically for swing, which reportedly eliminates friction clutches and requires no lining replacements, adjustments, or maintenance. The machine also has a sealed power box in which all gearing is completely enclosed and runs in a bath of oil. The boom is of T-1 steel tubular chord and lattice construction.

According to P & H, the Magnetorque swing clutches do not need the protection required of other clutch assemblies, and duty service demands of swinging the ball laterally are said to be easily handled because there are no friction elements to protect.

Experimental Fuel Cell Tractor

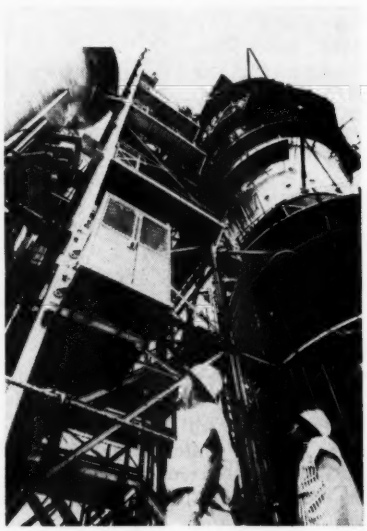
A NEW SOURCE OF ELECTRICAL POWER—fuel cell—has come out of the laboratory to power a vehicle for the first time. Allis-Chalmers Mfg. Co., Milwaukee, Wis., recently demonstrated its fuel cell-powered tractor. The experimental vehicle is powered by electricity generated within 1008 fuel cells. A mixture of gases—largely propane — fuels the cells which develop a total of 15 kw of electricity. The research vehicle develops 3000 lb of drawbar pull, more than enough to pull a multiple-bottom plow through dry, hard ground in field tests. Although the tractor is of commercial size, Allis-Chalmers researchers say it still is a research vehicle.

Research scientists and engineers and a number of large companies are now looking to the fuel cell as a more efficient method of converting chemical energy to electric energy. A few of the more recent fuel cells investigators include O. K. Davtyan in Russia (1946), E. T. Bacon in England (1935 to the present) as well as scientists of Pittsburgh Consolidated Coal & Coke Co., National Carbon Co. and others in the United States. Several types of fuel cells are being investigated. Among these are direct fuel cells utilizing solid fuel, semidirect fuels which utilize gaseous fuel, and indirect cells utilizing an oxidation-reduction system.

Traction Drive for Portable Personnel Elevator

OPERATING ON A VERTICAL MONORAIL, made up of ten-ft sections of "H" beam, the portable personnel elevator has a carrying capacity of eight men or 2000 lb. It reportedly can be dismantled, moved to a new location, and re-assembled, in a few hours. The traction equipment consists of a pair of driving drums at the bottom of the monorail column, the second of which is independently adjustable in order to facilitate cable alignment and equalization.

Safety is covered by the cable equalizer, which maintains equal tension on the two hoisting cables and trips a safety locking device in case there is abnormal stretch or cable break. Other safety devices include a limit switch to prevent over-travel; a governor to stop the car if it overspeeds and a gate control to prevent car movement unless both gates are closed. More information can be obtained from Hawkeye Products Corp., Iowa City, Iowa.



Conveyor Belt for 45° Idlers

PARTICULARLY ADAPTED FOR OPERATING OVER 45° IDLERS, the Ray-Man conveyor belt has been announced by Manhattan Rubber Division of Raybestos-Manhattan, Inc., Passaic, N. J. Advantages claimed by the manufacturer to result from the use of Ray-Man belt and 45° idlers include: lower initial cost because narrower belts and conveyor equipment will hold the same load as belts on 20° idlers; less space required for narrower conveyors; lower maintenance cost because there is less spillage; less wear on the belt, and cost of belt replacement is lower.

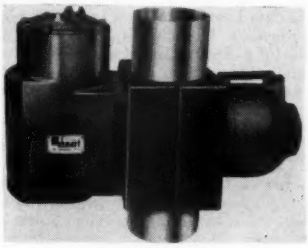
Principal problem in the past has been the fact that the sharp angle between concentrating and center rolls made belts difficult to train under heavy load, and flex-fatigue caused ply and cover separation. Ray-Man construction is said to be doubly compensated so that the outer ply stretches as the inner ply contracts under both lateral and longitudinal flexing, and even on reverse bends. The outer strength member plies reportedly are constructed with a special weave high-strength synthetic fabric of carefully controlled elasticity, which relieves the stress on the belt as it travels over idlers and terminal pulleys.

Safety Facepiece

FEATURING A LARGE SINGLE LENS, said to be readily replaceable, a new facepiece for gas masks, hose masks, air line respirators and demand breathing apparatus is being offered by Mine Safety Appliances Co., Pittsburgh, Pa. Called the MSA Clearvue, the facepiece is designed to eliminate fogging of the lens, and has a reportedly improved speaking diaphragm, and built-in accommodation for prescription glasses. MSA plans to incorporate it in virtually its entire line of masks, air line respirators and demand breathing apparatus.

Density Measuring Gages

FOR USE ON PIPES THROUGH EIGHT IN. in diam, two density gages are available for automatically measuring the specific gravity or percent solids of liquids flowing through processing lines. Model PG and Model PGV both utilize a point source of radioactive material



mounted in a safety shielded holder on one side of the line, and an Ohmart measuring cell on the other side. The cell detects radiation energy in proportion to the density of the material flowing past the gage, and changes it into an electrical signal which is amplified and fed to a recorder or controller for actuating pumps or valves. The gages measure spans as narrow as 0.15 sp gr units with a precision as narrow as 0.0015 units, and they are particularly suited to severe or hazardous locations since they do not contact the material being measured. Further details are available from the Ohmart Corp., 2236 Bogen St., Cincinnati 22, Ohio.

Wagon Train on Rubber

THE LATEST ENTRY in the field of dump truck haulage is a Wagon Train on Rubber from Differential Co., Box 228, Findlay, Ohio. This train is made up of a Powered Wagon with one, two, or more Wagons. These patented trains are built in two sizes, one for highway use with 15-ton capacity bodies, and a larger off-highway train with bodies carrying 25 tons each.

Differential says that it had in mind the providing of lowest haulage cost per ton of payload when it designed this patented train and points out three factors it says accomplish this: (1) Units dump clear of the roadway and keep moving; (2) the side dumping feature permits the use of multiple trailers, increasing loads hauled by each driver; and (3) the ratio of payload to tare weight is increased by means of all-welded construction and the use of light-weight, high-stretch material.

—ANNOUNCEMENTS—

Frank T. House has been appointed sales promotion manager and **Hermann A. Burkhardt,** publicity manager, for **Bucyrus-Erie Co.,** South Milwaukee, Wis.

House, originally a B-E sales representative in Atlanta, is being promoted to his new post from sales development manager, commercial cranes and excavators. Burkhardt is a 20-year veteran of the company's advertising and publicity department.

F. House

H. Burkhardt

Clarence Thom, director of the Ore Testing Division, **Denver Equipment Co.,** for 25 years, has recently been assigned new responsibilities by the company. In his new post of consulting metallurgist he will specialize in mineral beneficiation and will be primarily concerned with overall mineral recovery problems of mining firms at home and abroad.

Columbus McKinnon Chain Co., has announced the appointment of **Dale E. Hirschfeld** as district representative in W. Va., Va., Ala., Tenn. and eastern Kentucky for the recently introduced Ratio-Feeder for shuttle car to belt loading.

The **Allen-Sherman-Hoff Pump Co.** has moved its headquarters from Wynnewood, Pa., to a new building in Philadelphia's suburban area of Frazer. Address of the new building, which will house the sales, service and engineering staffs, is P. O. Box 635, Paoli, Pa.

Russell L. Lepley has been named by **Connelsville Mfg. & Mine Supply Co.** to be vice president and general manager. He was promoted from production manager and his service with the company covers 25 years in a variety of duties.

Joseph G. Solari has been appointed vice president in charge of sales for **Great Lakes Carbon Corp's.,** carbon division. In addition to a varied industrial background, Solari served in 1952 and 1953 on the Federal Coal Mine Safety Board of Review.

A new sales office and warehouse has been opened in Arvada, Colo., by **Lee-Norse Co. Leif Arentzen** is district manager and sales representative, with **George Barger** in charge of the warehouse. The branch will carry a complete stock of replacement parts for the company's several products in Colorado, Utah and surrounding states.

A new company to be known as **Conveyor Belt Service, Inc. of Ohio** has been formed according to an announcement by **William A. Mars,** Duluth, president of **Conveyor Belt Service, Inc.** The new firm will provide eastern industrial operations with a repair and reconditioning service for conveyor belting, similar to that now offered in Minnesota.

CATALOGS & BULLETINS

HOSE FITTINGS FINDER. *W. O. Murray, Parker Fittings & Hose Div., Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio.* Bulletin 4406B1 contains helpful information for selection of industrial hose and fittings in regard to hydraulic pressures and other operating conditions. Five types of reusable fittings in a variety of ends are illustrated. For assemblies with permanently attached ends, 13 kinds of hose and 13 different ends are shown. Also presented are hose fitting adapters and hose assembling equipment.

HIGH PRESSURE MAGNETIC SEPARATORS, *S. G. Frantz Co., Inc., P. O. Box 1138, Trenton 6, N. J.* Four page bulletin outlines design and operating advantages of Frantz high pressure "Ferrofilter" magnetic separators for hydraulic systems. It includes descriptions of the industrial PH series with working pressures from 2000 to 5000 psi and the aircraft PX series with working pressures up to 3000 psi.

(Continued on next page)

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BUTTERFLY VALVE. *Henry Pratt Co., 319 W. Van Buren St., Chicago 7, Ill.* Bulletin 10GW illustrates and describes the Manoflange Mark II Rubber Seat Butterfly Valve. The manufacturer claims the catalog has been designed to be the ideal working tool for engineers and users of this type of equipment. Included are complete specifications, certified dimension drawings, water flow data, gas flow data, weights and freight rates and prices.

ROTATING DISC CONTACTOR. *General American Transportation Co., 135 S. LaSalle St., Chicago 90, Ill.* Bulletin No. T-1159, "Turbo Mixer RDC", describes and illustrates this gravity-flow countercurrent extractor—a compartmented column using rotating discs to create the proper environment for the transfer of one substance from one immiscible phase to another by passing the two phases in opposite directions while promoting intimate contact. This reportedly applies not only to liquid-liquid, but also to liquid-solid, or liquid-slurry. Also included is detailed information about background, application and some typical systems now in service.

CRAWLER TRACTOR. *Euclid Div., General Motors Corp., Cleveland 17, Ohio.* Form No. 607 describes Euclid's Model C-6 crawler tractor. It is well illustrated with photographs of job applications, cutaways, sectional views and drawings explaining full power shift, Torqmatic Drive, hydraulic track tensioning and other design and operating features of the tractor. There are also condensed specifications and performance charts, as well as data on hydraulic and cable control attachments.

MEASURING AND CONTROL SYSTEMS. *The Ohmart Corp., 2236 Bogen St., Cincinnati 22, Ohio.* Bulletin 105-C describes the operating principles, performance, and advantages of Ohmart measuring systems for density or specific gravity and liquid level control. Gages described are said to provide continuous, accurate and automatic control of such parameters as percent solids in a slurry, interface passage in pipelines, level of liquids in vessels and towers, and the control of the output densities of evaporators, thickeners and dryers.

DRAFTSMEN'S AIDS. *Keuffel & Esser Co., Adams and Third Sts., Hoboken, N. J.* "Keep it Clean!" is a two color, four page folder describing K&E's line of materials designed to help draftsmen clean and protect drawings. It includes order numbers and prices.

PROCESSING EQUIPMENT. *Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.* Catalog 25C6177P covers various types of Allis-Chalmers equipment for the process industries. Included are descriptions of compressors, vacuum, centrifugal, axial flow and turbine pumps, and valves for fluid flow; crushers and grinding and roller mills for disintegration, mixing and agglomeration; vibrating and gyratory screens for dry separation; blade mills, pool washing screens and log washers for liquid separation; kilns; dryers, slakers, pelletizers, coolers, and liquid heaters for heat transfer.

PORTABLE AND POWER CABLES. *Construction Materials Div., General Electric, Bridgeport 2, Conn.* GE's wire and cable department has issued Publication No. WC-8099, which includes a complete run-down on portable and power cables for use in underground mining, both a-c and d-c systems, and for strip mining and pits and quarries, as well as heavy portable cables for gantry cranes and earth moving equipment. Technical and specification data is given for the complete line of cables and for the various components such as conductors, insulation and jackets. Splicing and terminating details are also included.

WATER SPRAY NOZZLES. *The Deister Concentrator Co., 905 Glasgow Ave., Fort Wayne, Ind.* Series J-132 and Series J-136 nozzle data is available in a two color folder just released. It includes illustrations and charts fully descriptive of these series with complete information on use, installation and performance advantages.

WRENCHES. *Lowell Wrench Co., Worcester 4, Mass.* Catalog 62 shows the complete line of Lowell reversible ratchet wrenches and includes a simplified method for figuring correct wrench size for any bolt or nut diameter. Full specifications and details are given for Warnock Strap Wrenches and Swaco Railroad Car Movers and Hopper Car Wrenches.

FLOOR GRATING SYSTEM. *Equipto, Aurora, Ill.* Equiptogram No. 307 gives full details and prices of components used to give double shelf area in same space. Present shelving can be extended as ceiling height permits and non-skid steel catwalks installed complete with access stairway.

TRUCK CRANE. *American Hoist & Derrick Co., 63 S. Robert, St. Paul, Minn.* Catalog No. 770-TG-2 describes the American 60-ton truck crane and includes illustrations of the equipment in action on many engineering projects.

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coming and going

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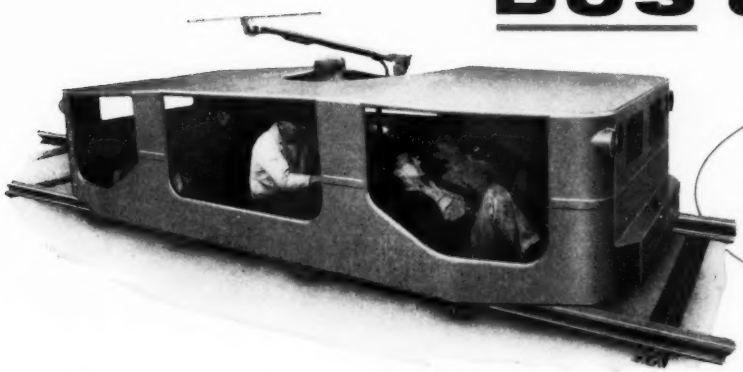
BUS & JITNEY



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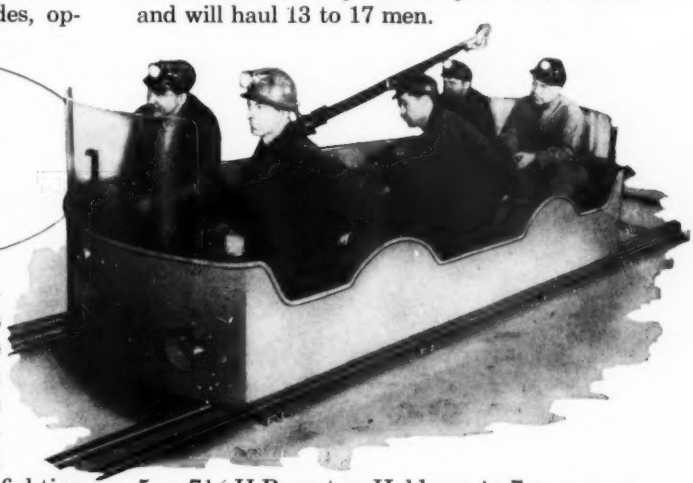
MINE PORTAL BUS

■ There's no wasted motion with this self-propelled Portal Bus because it is fast on the take-off, saving manpower time for conversion into more tonnage. And it is designed for safety, with hydraulic operated running brakes plus mechanical emergency and parking brakes direct on the wheels. For severe grades, optional electric dynamic system produces braking effect from the motor for *extra* safety under all conditions. Also the split roof construction gives operator unimpeded, all directional view, while the trolley pole is always within quick reach. This bus is powered by 15 H.P. motor and will haul 13 to 17 men.

Lee-Norse
MINE JITNEY



■ The Mine Jitney is the "Jack-of-all-Trades" of the mine fleet because its versatility enables it to be used on the regular job and for emergency. It can handle the job of furnishing fast, safe transportation of key personnel, maintenance crews and special groups; and can double up as an ambulance or fire-fighting equipment car. Designed with twin braking systems for added safety. Powered with either 5 or 7½ H.P. motor. Holds up to 7 men comfortably. Optional equipment: Plexiglas windshield, fire extinguisher, stretcher equipment.

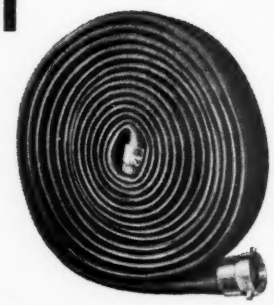
LN

Lee-Norse Company

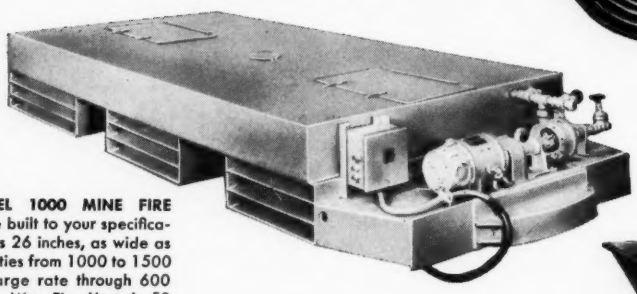
CHARLEROI, PENNSYLVANIA

SPECIALISTS IN COAL MINING EQUIPMENT

THESE MSA PRODUCTS HELP YOU FIGHT MINE FIRES INSTANTLY

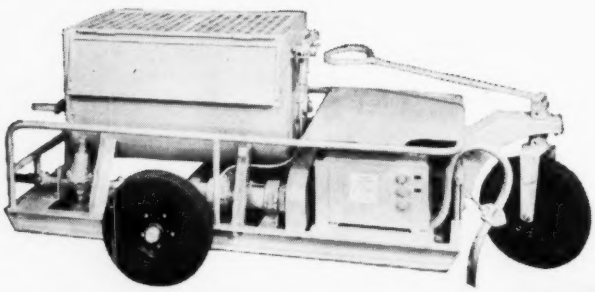


M-S-A MINE FIRE HOSE is especially designed for rugged mine use. It's impervious to rot and vermin. Never needs drying. Lightweight. Easy to handle. Dated and branded for your protection.



M-S-A BANTAM 400 ROCKDUST DISTRIBUTOR applies rockdust wet or dry. Availability of this machine in the working place, and the men's familiarity with its operation, make it ideal for fighting fires at their inception. Discharges dry dust through as much as 400 feet of hose at an average of 30 lb. per minute. Discharges wet dust at a rate of 50 lb. per minute through 150 feet of hose.

M-S-A MODEL 1000 MINE FIRE TRUCK can be built to your specifications: as low as 26 inches, as wide as 7 feet. Capacities from 1000 to 1500 gallons. Discharge rate through 600 feet of M-S-A Mine Fire Hose is 50 gallons per minute at 50 psi.



M-S-A SLURRY ROCK DUST DISTRIBUTOR can pump a slurry of rockdust and water—the cheapest fire-fighting agents for mine fires—through as much as 1000 feet of hose at the rate of 120 lb. per minute.

M-S-A MODEL 2100 MINE FIRE TRUCK has 2100-gallon capacity. Discharge rate through 600 ft. of M-S-A Mine Fire Hose is 91 gallons per minute at 150 psi. Tank is fully baffled with triple weld construction. Truck is designed for easy maneuverability.

Any delay in fighting a fire may prove disastrous. Often, the sealing of an entire mine or section results. Such an operation is not only hazardous. It's costly.

This threat to human lives and vital mining equipment, however, can be greatly reduced. You can do it with one or more of the indispensable items described above.

A minimum investment in MSA fire-fighting equipment *now*, may save you thousands of dollars later. Write us for helpful literature.

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